

A Contribution to the Knowledge of the Puparia of Anthomyidae

by

MACHTILDA N. STORK

Introduction.

In the Diptera Cyclorrhapha the last larval skin is retained as a covering for the pupa. The full-grown larva, when going to pupate, ceases moving about and contracts, completely withdrawing its head and sometimes a part of the prothoracic segment too. The skin changes more or less its shape. It grows harder, brittle and darker, and finally becomes completely loosened from the insect which it encloses. The thus formed pupal covering, which occurs in all Diptera Cyclorrhapha, is called puparium. When the imago emerges, the typical puparium of the Eumyidae [including the *Conopidae*, *Oestridae*, *Tachinidae* and *Anthomyidae* (*Muscidae*)] opens along two horizontal lines, which meet at the anterior end, and a circular line. The horizontal lines run on the lateral sides of the thoracic segments and some way into the first abdominal segment. They divide those segments into a dorsal and a ventral part. The dorsal part bears the larval prothoracic spiracles, the ventral part contains the mouth-opening and the adhering cephalopharyngeal skeleton. In the fore-part of the first abdominal segment each horizontal line divides itself into a descending and an ascending branch, which form the circular line of dehiscence.* (The term "cyclorrhaphous", derived from these lines, will be discussed later-on.) So two semi-circular, curved plates are pushed apart by the emerging imago. The hinged plates often remain attached to the rest of the puparium, near the median line, as the splits of the left side often do not meet those of the right side. In most *Oestridae* the line of dehiscence is lacking on the ventral side. So here only a dorsal plate is pushed off. In *Drosophila* also the dorsal plate is turned back by the emerging imago, and the descending branch does not aid in emergence (Miall and Taylor). In the dorso-ventrally depressed puparia of *Homalomyiae* also only the dorsal plate is loosened, if loosened at all (de Meijere 1900). In *Phytomyza*

*) The term "line of dehiscence" was proposed by Miall and Taylor (1907), who object to the term "suture", used by other authors, as this term suggests a line of union of distinct morphological elements, as in the phrase "suture of the skull".

ilicis Curt. (*aquifolii* Gour.) it is the ventral plate which is turned back (Miall and Taylor). Likewise in the particular -shaped puparium of *Hydromyza livens* Fall. The deviating ways in which the puparia of other cyclorrhaphous Diptera open (*Lonchoptera*, *Phoridae*, *Platypezidae*, *Pipunculidae*, *Syrphidae*) are studied by de Meijere (1900, 1916). In the *Phoridae* for instance a small lid is loosened at the anterior end. The posterior border of this lid lies dorsally in the fore-part of the first abdominal segment, ventrally not farther than the anterior border of the second thoracic segment. Besides, on the dorsal side a trapezoid plate is loosened, lying immediately behind this lid and almost reaching with its posterior border the posterior end of the third abdominal segment. Moreover, this plate splits open along a median longitudinal line. So here are median and lateral longitudinal lines of dehiscence in the first 3 abdominal segments or (f.i. in *Phora bergenstammi* Mik.) in the third thoracic segment besides. The dorsal transverse lines mostly lie in the first and third abdominal segments.

In the Diptera Orthorrhapha the last larval skin is cast off, except in the *Stratiomyidae* and in some *Cecidomyiidae*, where it stays and loosely engulfs the pupa.

The skin of the *Stratiomyid* larvae is leathery and often impregnated with calcareous matter. At pupation it does not change its shape or texture. When the fly emerges, the larval skin opens along a T-shaped split. Its longitudinal part lies in the middle of the dorsal side, from the second thoracic segment to in the first abdominal segment. At its anterior and posterior ends is a short, transverse split. So it differs entirely from the typical, mostly ovoid puparium of the *Muscidae*.

In the *Cecidomyiidae* the pupa is usually enclosed in a cocoon, which may be either single or double. In *Mayetiola*, perhaps in some other *Cecidomyiidae* besides, the outer layer is formed by the skin of the second-stage larva. It hardens, becomes smooth and assumes the appearance of a puparium. The *Cecidomyid* larvae however are peripneustic so that the remaining skin actually differs entirely from that of the amphipneustic cyclorrhaphous larvae. Besides, the imago issues at the posterior end, between the eighth and ninth segment.

Bouché (1834) proposed a division of the Diptera into two groups: Group I, where the pupa is free (*nympha velata* Bouché, pupa *exarata* Burm.), and group II, where the pupa is enclosed by the larval skin (*nympha inclusa* Bouché, pupa *coarctata* L.). From the foregoing it is clear that this division does not lead to a natural classification.

The still usual division into Diptera Orthorrhapha and Diptera Cyclorrhapha goes back to Brauer. He first proposed

this division in his "Monographie der Oestriden", published in 1863. As the terms orthorrhaphous and cyclorrhaphous are not interpreted by different authors in the same way, the paragraphs, where they are explained by Brauer loc. cit. follow :

"Diptera orthorapha : Die Larvenhaut öffnet sich bei der letzten Häutung mit einem Längsrisse auf der Rückenseite in der Mittellinie vom zweiten bis zum vierten Segmente, zu welchem am vorderen Ende ein Querriss hinzukömmt, so dass eine "T"förmige Spalte zu Stande kömmt. Die Larvenhaut wird entweder bei der Verpuppung in dieser Weise abgestreift, und die Nymphe ist eine freie, sogenannte Mumienpuppe, oder sie bleibt als schützende Hülle um die Nymphe und berstet in obiger Weise erst beim Auskriechen der Imago."

From this paragraph it appears that the T-shaped split, situated dorsally in the middle of the second, third and fourth segment, along which the last larval skin opens, is considered by Brauer as being the characteristic feature of this group. Meanwhile it appears, however, from the investigations of de Meijere that also in some Cyclorrhapha a longitudinal split occurs on the dorsal side (*Phoridae*, *Lonchoptera*). In most Orthorrhapha the last larval skin is opened by the pupa, (in this case the pupa is free), in the *Stratiomyidae*, however, it is not opened until the imago emerges (here the pupa remains enclosed). In the latter case the breaking through of the larval skin may be looked upon as a delayed ecdysis. Actually the skin opens in the same way as in former ecdyses. *Xylomyia* (*Subula*, a *Stratiomyid*) takes an intermediate position between those Orthorrhapha with a free pupa and those with an enclosed pupa. In *Xylomyia* the pupa remains enclosed by the larval skin until the imago appears. Then it emerges more than halfway from the larval skin.

The group of the Diptera Cyclorrhapha is characterized by Brauer loc. cit. as follows :

„Die Larvenhaut wird bei der Verpuppung niemals abgestreift, sondern erhärtet im contrahirten oder seltner gestreckten, aufgeblasenen Zustande zu einer verschieden gestalteten, meist ovalen, dunklen, in der Form sehr selten der Larve ähnlichen, wahren Tonne, die durch Tracheen in vitaler Verbindung mit der Nymphe bleibt. Nach Ablauf des Nymphenstadiums öffnet sich die Tonne (Larvenhaut) niemals längs der Mittellinie vorne an der Oberseite, ¹⁾ sondern stets in der Richtung von *Bogennäthen* *) mit einem oder zwei abfallenden Deckeln. Es sind drei Fälle möglich, welche übrigens zu einer weitem Eintheilung nicht anwendbar scheinen.

*) The italics are mine.

1. Es öffnet sich das vordere Ende in der Richtung einer horizontal verlaufenden Bogennaht, zu der am vierten Ringe eine quere, senkrechte Bogennaht hinzutritt, wodurch das vordere Ende in Form von zwei halbmondförmigen Deckeln abfällt (*Cephonomyia*, *Anthomyia* u.a.)."

It does not serve our purpose to quote the second and third cases, described by Brauer. It is often thought that the term "cyclorrhaphous" only refers to the vertical line of dehiscence. From the paragraphs quoted here, it seems to me most probable that this term is derived from the horizontal as well as from the vertical lines of dehiscence. For Brauer, in the exposition of the characteristics of the Cyclorrhapha, mentions circular lines of dehiscence (in plural), and in case 1. he distinctly mentions a horizontal circular line of dehiscence. As a matter of fact the horizontal as well as the vertical lines are more or less curved.

It is shown by the investigations of de Meijere (1900, 1916), that in a number of Diptera the puparia open in still other ways than those, described by Brauer. The circular lines of dehiscence are not characteristic for the puparia of all Cyclorrhapha. So this investigator arranges *Lonchoptera*, in which the fly emerges along a T-shaped split, among the Cyclorrhapha. Yet Brauer's division into Diptera Orthorrhapha and Cyclorrhapha is still usual and his classification, except for some alterations, is corroborated by characteristics of the larval, pupal, and imaginal stages. It is not the place here, however, to go into this matter.

The Cyclorrhapha in their turn are divided into two groups, depending on the presence or absence of a ptilinum. In the *Eumyidae* and in the *Pupipara* (*Hippoboscidae*, *Nycteribiidae*) the puparium is opened by way of the ptilinum or frontal sac. It is formed by the invagination of a part of the imago's head-wall. It is indicated externally by the arched frontal or ptilinal suture, an extremely narrow slit, lying transversely above the antennae. It extends downwards on the right and left sides of the antennae, thus presenting a \cap -shaped form. After this suture the above mentioned groups together are called *Schizophora*. The ptilinum lies in the cavity in front of the brain. When the imago is ready to emerge the sac is ejected and distended in front of the head under pressure from within. Thus it presses upon the wall of the puparium, till the latter bursts open. After the fly has emerged the ptilinum is withdrawn into the head cavity and does not function any longer. The Cyclorrhapha, where no ptilinum is present, are taken together under the name *Aschiza*. The ptilinum is also lacking in the Orthorrhapha. Here the puparium is opened by means of the head and the thorax pushing against the wall.

Although the study of the pupal instar plays an important part in the system of Diptera, little attention has been paid by most authors to its detailed morphology. The descriptions of puparia are mostly very short and often remain confined to short indications concerning their colour and shape. Still this instar deserves as much attention as that of the larvae and imagines. Even in the Cyclorrhapha a complete description of the puparia is desirable as the larval skin has undergone some changes when becoming a puparium. Our knowledge about the morphology of a species is not complete without the investigation of the puparium. Sometimes it is desirable to state the name of a species of which only a puparium is available. Besides, a detailed description of the puparium of a species may be helpful in identifying the still unknown larva, and conversely.

In the following descriptions the puparia are compared, when possible, with the larvae described by other authors. Only the cephalopharyngeal skeleton is to be left out of consideration here as its details are not clearly perceptible through the darkened larval skin, and its natural position is more or less changed. In many species the larval characteristics are still visible in the puparium, in others some particularities have become less clear (as is often the case with the number of lobes on the prothoracic spiracles), or even have quite disappeared (as the papillae on the posterior end of the larva in *Pycnoglossa cinerosa* Zett.). So studies about dipterous larvae as those of Brauer, de Meijere, Keilin, Nielsen, de Vos-de Wilde, Hewitt, Banks, Howard and others are of great importance to the study of the puparia. The authors making a special study of the puparia of a certain group or family are few in number; Brauer, de Meijere, Greene and Vimmer may be mentioned here. Malloch (1918) composed a "Preliminary Classification of Diptera, Exclusive of Pupipara, Based upon Larval and Pupal Characters", but this extensive publication is confined to the Orthorrhapha (Nematocera and Brachycera).

We describe in the following pages the puparia of 35 species of *Anthomyidae* sensu latiore Girschner (*Muscidae* Karl 1928). Karl divides this family into 6 subfamilies, i.e., *Muscinae*, *Phaoniinae*, *Eginiinae*, *Mydaeinae*, *Anthomyinae* and *Coenosinae*. The genera *Musca* L., *Myiospila* Rond., *Mesembrina* Mg., *Muscina* Rob. Desv., *Morellia* Rob. Desv., *Haematobia* Rob. Desv. and *Lyperosia* Rond., described here, have to be arranged among the *Muscinae* (Karl). The other species examined, belonging to the genera *Pegomyia* Rob. Desv., *Hylemyia* Rob. Desv., *Chortophila* Macq., *Pycnoglossa* Coqu., *Phorbia* Rob. Desv. *Heterostylus* Schnabl and *Paregle* Schnabl are classified under the subfamily *Anthomyinae*. Concerning the genera the nomenclature and the arrangement

of Karl is followed. The nomenclature used by Séguéy is added in italics when different. Species, belonging to the same genus are arranged alphabetically.

The material examined was kindly put at my disposal by Prof. Dr. J. C. H. de Meijere. Partly the puparia were collected as such, partly they were reared from collected larvae. A number of the puparia was collected by Mr. L. H. Scholten in alluvial deposit of the river Rhine, after the inundations in the beginning of 1924 and 1926. The material was sent to Prof. de Meijere in Amsterdam, who reared the puparia separately in glass-tubes, provided with moistened moss, and identified the emerged imagines. So to get acquainted with the puparia, each fly was kept together with the puparium from which it emerged.

Of some species only one specimen was available. In most cases, however, more specimens could be examined. Here it could be established that the puparia of *Anthomyidae* show characteristics, by which even species, belonging to the same genus, are distinguishable. Of the 35 species of puparia examined 34 showed marked differences. Only between those of *Paregle aestiva* Mg. and *Heterostylus pratensis* Mg. no distinguishing features could be found. Except differences in size, colour and shape, in the number of lobes on the larval prothoracic spiracles and in the absence or presence of pupal breathing-horns, the most characteristic features are found on the posterior end.

Puparia, with a length less than 6 mm here are called small, those with a length from 6 to 8 mm are called medium-sized, puparia more than 8 mm long are indicated as being large. As a matter of fact the size varies according to the amount of food consumed by the larva. Also the colour may vary in specimens of one and the same species. Most puparia are suddenly narrower or rounded off towards their anterior end. The posterior end is often rounded or gradually flattened (fig. 4, 8, 12). These puparia are indicated as being normally shaped. In most species of *Chortophila* and *Hylemyia* the posterior end is obliquely flattened, so that the ventral side of the last segment is somewhat longer than its dorsal side. An abruptly obliquely truncated posterior end is found in *Chortophila discreta* Mg. (fig. 18), which also in other respects differs greatly from other *Chortophila* species. In *Hylemyia lasciva* Zett. there is a slightly protruding rim round the flattened posterior end. *Mesembrina meridiana* L. and the genus *Morellia* Rob. Desv. deviate from the normal barrel-shape by the abruptly truncated posterior end, which is encircled by a distinctly protruding rim (fig. 3, 5 and 6). The *Morellia*-species, besides, are very conspicuous by the reticular structure all over the skin.

In many species a part of the skin is covered with spines,

arranged in belts, which partly or completely encircle the puparium. No spines whatever are found in *Haematobia stimulans* Mg., *Lyperosia irritans* L. and *Chortophila discreta* Mg. In *Paregle radicum* L., *Chortophila seneciella* Meade, *Chortophila signata* Brischke, de M. and *Chortophila fugax* Mg. the whole skin is covered with spines. The tops of most spines are turned backwards. This situation makes locomotion in a forward direction possible. Only in *Chortophila latipennis* Zett. most spines are turned forwards. Here, however, they are extremely small, so that, doubtlessly, they do not impede locomotion. The brown spots, visible in most species along the junctions of the segments are the places where in the larva the muscles are attached.

As the larva completely retracts its head when going to pupate, only 11 segments are visible on the puparium, i.e., 3 thoracic and 8 abdominal segments. The first thoracic segment bears on its dorsal side the larval prothoracic spiracles. In many cases the lobes are clearly visible, so that even their number can be established.

Pupal breathing-horns, perforating the puparium on the posterior border of the first abdominal segment, were found by me in *Musca domestica* L., *Myiospila meditabunda* Fabr., *Muscina stabulans* Fall., and *Haematobia stimulans* Mg. In *Mesembrina meridiana* L., where they are found by de Meijere (1902) only a round, hyalin spot was found by me there on the left side. Likewise in 2 of the 3 specimens of *Musca domestica* L. Here the horns probably were shorter than usual, or remained horizontal so that they did not break through. The pupal breathing-horns are studied by de Meijere (1902) throughout the entire group of Diptera. The horn has to be considered as an appendage of the prothoracic skin of the pupa. Inside the horn lies the felt-chamber, which lower down passes into the taenidia-bearing part of the tracheal trunk. On the horn lies a number of thin-walled slits, through which the air passes. Such horns, widely differing in shape, occur in many families of the Diptera Orthorrhapha (Nematocera as well as Brachycera) and Cyclorrhapha. In the latter they may perforate the puparium in preformed, round, thin-walled spots. In the *Lonchopteridae* and *Phoridae* these spots lie on the second abdominal segment, in the *Pipunculidae* between the first and second abdominal segments, in the *Syrphidae* and *Eumyidae* on the posterior border of the first abdominal segment. (In the *Stratiomyidae* perforation never occurs.) In *Acalyptрата* perforation was found by de Meijere in *Leria fenestralis* Fall. and in some *Agromyzids*. In many, though not in all *Tachinidae* and *Anthomyidae* the horns break through. In all *Schizophora*, where perforation takes place, a second spiracle, showing numerous slits, is formed at the under end of the felt-chamber. This inner spiracle lies

on the skin of the pupa. The pupal skin is found in empty puparia lying close to the inside of the wall. De Meijere loc. cit. gives a drawing of a pupal breathing-horn of *Muscina stabulans* Fall., in which the external as well as the inner spiracle is sketched. This author mentions finding a well-developed inner spiracle also in many *Schizophora*, where the pupal breathing-horns are shorter, and do not break through.

The most distinguishing features are found on the posterior end of the puparia. The position and shape of the slits on the posterior spiracles is very characteristic. In the *Anthomyiinae* the 3 slits are short and straight. They converge to the scar, which is situated high-up or lower down at the inner edge of the stigmal plate. In *Hylemyia lasciva* Zett. the slits are slightly curved. In *Chortophila lineata* Stein the position of the scar and slits is very conspicuous (fig. 20). In the *Muscinae* the slits are often longer and slightly curved or even sinuous (fig. 1, 3, 5, 6). In most species they do not converge, but are situated round the scar. In *Muscina stabulans* Fall. and *Myiospila meditabunda* Fabr., however, the lobes are short and converge. The distance between the spiracles, expressed in proportion to their horizontal diameter, is also a good distinguishing mark. The position of the spiracles is indicated with respect to the horizontal diameter of the posterior end. This can be done very well in all those species, where the posterior end is encircled by a number of papillae or by a protruding rim. In species, however, where these are lacking, this may cause some difficulty. In most of the latter cases their position was established in regard to the medio-horizontal line as is done by Greene in his studies about the puparia of *Tachinidae*, *Sarcophagidae* and *Trypetidae*. This line, called longitudinal axis in a former publication of this author, is constructed as follows: after having drawn the puparium viewed exactly from the lateral side, i.e., so that the two posterior spiracles are lying exactly one behind the other, the centre of its largest vertical diameter (a) can be established without difficulty. The line, drawn through this centre, at an angle of 90 degrees to a, is the medio-horizontal line.

The number and shape of the papillae on the posterior end varies widely in different species. Most papillae are situated in pairs, i.e., one on the right side, the other on the left. Only in some specimens a single, unpaired papilla is present, called supra-anal papilla, as it lies over the anal opening. One single supra-anal papilla was found on *Chortophila cinerea* Fall., *Chortophila antiqua* Mg., and *Chortophila dissecta* Mg., 2 single supra-anal papillae, lying one above the other are present in *Chortophila florilega* Zett.

Subfamily *Muscinae*.*Musca domestica* L.

Fig. 1.

Larvae found in Amsterdam, not further specified.

Puparia small: length 5,5 mm., largest diameter 2 mm. (According to Hewitt (1910) the average length of the pupa is 6,3 mm.) Colour deep reddish brown, the button-like posterior spiracles black. Shape normal: the anterior and posterior ends almost equally rounded, the sides of the first 6 abdominal segments almost parallel. Segmentation indistinct, microscopically indicated by rows of inconspicuous brown spots. A few rows of inconspicuous spines only on the ventral side at the junctions of the segments. 4 rows of slight hollowings-out on the sides of only one of the 3 puparia examined. The skin of the first thoracic segment "creased", the rest of the puparium finely transversely wrinkled. The cephalopharyngeal skeleton reaching well into the first abdominal segment.

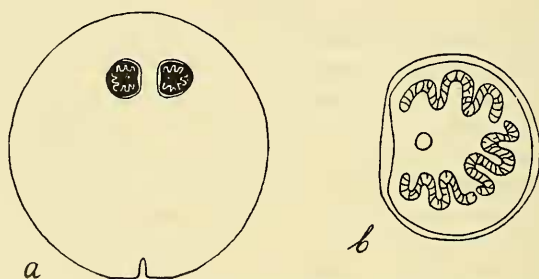


Fig. 1. *Musca domestica* L.: a posterior end ($\times 23$), b right posterior spiracle ($\times 115$).

The larval prothoracic spiracles with 7 lobes. Hewitt (1910) counts 6 to 8 lobes. This author describes the pupal spiracles as a pair of spine-like lateral projections. Only on one of the 3 puparia examined on the left side a dark, small pupal-horn present. On the other side and on the two other specimens only small, white, round spots perceptible. These spots, lying high-up on the lateral sides, in front of the row of spots between the first and second abdominal segments, are the places, where the pupal breathing-horns ought to break through. The pupae of the specimens examined being not quite developed, the perforation has not taken place here. The posterior spiracles black, slightly protruding, encircled by a lighter-coloured, brown ring at their bases. Their position high above the medio-horizontal line. The spiracles are described by Hewitt as being D-shaped, with the corners rounded off, and their flat faces opposed. Either spiracle with 3 sinuous slits. Each slit with 2 or 3 bends.

The brown chitinized bars, lying across these slits very distinct. The scar, near the flat side, scarcely perceptible as a round spot, somewhat lighter coloured than the rest of the stigmal plate. The distance between the spiracles less than once their horizontal diameter. No papillae on the posterior end. The anal opening slit-like.

The pupal breathing-horns, the position and shape of the posterior spiracles, the sinuous slits, each with 2 or 3 turnings, and the few inconspicuous spines on the skin are the most characteristic features of the puparium of this species.

See the monograph of Hewitt (1910), entitled "The House Fly", for extensive details about the breeding habits, development, morphology and anatomy of *Musca domestica* L. The flies prefer horse manure as a nidus for the eggs, but also oviposit in human excrements, cow-dung and poultry excrement, in various substances contaminated or mixed with excremental products, such as a bedding from piggeries, from rabbits and guinea-pigs, in contaminated paper and textile fabrics, in decaying vegetable substances such as refuse from kitchens, rotten fruit, in waste food-stuffs, as bread moistened with milk, boiled eggs, broth, in bad meat and dead animals.

***Myiospila meditabunda* Fabr.**

Fig. 2.

Puparia found in alluvial deposit of river Rhine near Herwen, and one specimen under sods, Amsterdam.

Medium-sized: length from 6 to 6,5 mm., largest diameter 2,5 mm. Colour reddish brown, only the pupal breathing-horns and the posterior spiracles black. Shape normal: narrowing towards the anterior end, rounded off at the posterior end. A distinct constriction at the first and second abdominal segments. Segmentation marked by conspicuous rows of brown spots. These rows on the lateral sides branched off into 2 rows, which join again somewhat farther on. On the lateral sides between the transverse rows, some small, sinuous rows of spots, running longitudinally. On the dorsal side of the last segment 3 short longitudinal rows of spots, on the middle of the ventral side a fourth one. No spines on the dorsal and lateral sides. On the ventral side from 1 to 3 rows of spines on the anterior borders of the abdominal segments. These spines very large, irregularly shaped, with their tops turned to the posterior end. The first thoracic segment creased, the rest of the puparium very finely transversely striated. The cephalopharyngeal skeleton reaching into the first abdominal segment.

The prothoracic spiracles not clearly perceptible. The pupal

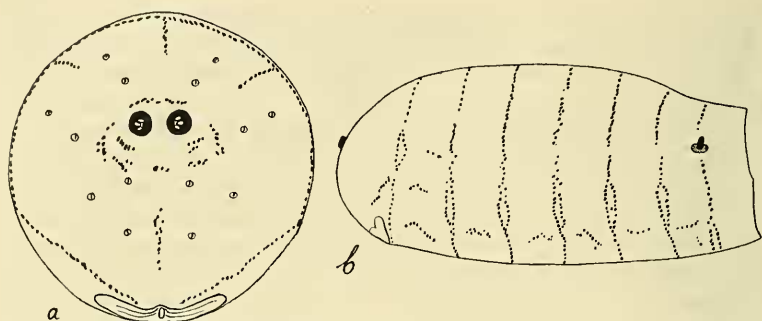


Fig. 2. *Myiospila meditabunda* Fabr.; a posterior end ($\times 18$), b puparium viewed from the side ($\times 11$).

breathing-horns black, turned obliquely upward, situated on the posterior border of the first abdominal segment. The posterior spiracles on black, parallel protuberances, situated a short distance above the medio-horizontal line. The distance between them less than once their horizontal diameter. Either spiracle with 3 short, wide lobes, which converge slightly. The peritreme and stigmal plate black. The scar not discernable. No papillae on the posterior end, but a few small, very inconspicuous round spots, in each of which a dark sensory-hair. 7 pairs of these spots perceptible on either of the 2 specimens examined, though less conspicuous than on fig. 2a. Besides, round the posterior spiracles a number of brown spots. Round the anal opening a reddish-brown, transverse elongated border.

The puparia, found in different places, show exactly the same features.

The pupal breathing-horns, the distinct rows of spots, the large spines on the ventral side, the black posterior spiracles with the short, broad lobes, and the small, round spots with sensory hairs on the posterior end are the most characteristic features of the puparia of this species.

Keilin (1927) records that the slits of the posterior spiracles are slightly curved. This is scarcely visible any longer on the puparium.

Portchinsky (1910) and Keilin give details about the biology and morphology of the larva and puparium. The female lays from 24 to 30 eggs, which are deposited one by one in the excrements of man, of cattle, and but rarely in those of horses. The larva hatches within 24 hours. The first and second larval stages are of short duration. The third stage may be reached already on the third day. While the larvae in the first two stages are coprophagous, they become carnivorous in the third stage and play havoc among other larvae, living in the same substances.

A very peculiar phenomenon is that the full-grown larva constructs a cocoon before pupation. The process was studied and recorded in details by Keilin. The larva, when full-grown, lies almost motionless for one or two days in the substance in which it lives. During this time it secretes from its mouth a slimy and sticky substance, which moistens its immediate surroundings. This secretion penetrates by the action of capillarity between the solid particles round the larva, and then it becomes hard, thus joining together all those particles. While forming in this way a more or less regular-shaped cocoon, the larva continues secreting the mucous matter, thus doubling or tripling its covering. Sometimes this secretion solidifies in threads, sometimes in very thin plates, and the cocoon, so formed, is not completely closed; it suffices to lift the adhearing particles to see the meshes of different size. Often 2 or 3 larvae construct their cocoons one next to the other, so that the cocoons are joined together and can only be separated with the greatest of difficulties.

Myiospila mediatubunda Fabr. is also described by Howard (1900) as a dung-breeder, and is also recorded in the study of Banks about "The Structure of Certain Dipterous Larvae with Particular Reference to Those in Human Foods" (1912).

Mesembrina meridiana L.

Fig. 3.

Larva found in cow-dung, Zwammerdam.

Puparium large: length 11 mm., largest diameter 4.5 mm. Colour reddish brown, the sides of the last segment darker coloured, the posterior spiracles black. The puparium widest on the third abdominal segment. From there on tapering towards the posterior end. The last segment constricted at its anterior border, then abruptly perpendicularly truncated, and encircled by a thin, protruding rim, which shows a number of longitudinal chitin thickenings. This rim broken in the middle of the ventral side. Segmentation distinct, indicated by rows of brown spots. Each of these rows laterally branched off into 2 rows, which meet again somewhat farther on. No spines on the dorsal and lateral sides. On the ventral side of the abdominal segments, from the second segment onwards, belts of large spines. On the second and third abdominal segment from 1 to 4 rows of these spines, on the following segments from 6 to 9 rows. The number of rows diminishing towards the lateral sides. The first thoracic segment longitudinally wrinkled, the sides of the eighth segment creased. The rest of the puparium finely transversely wrinkled. The cephalopharyngeal skeleton reaching to the posterior border of the first abdominal segment.

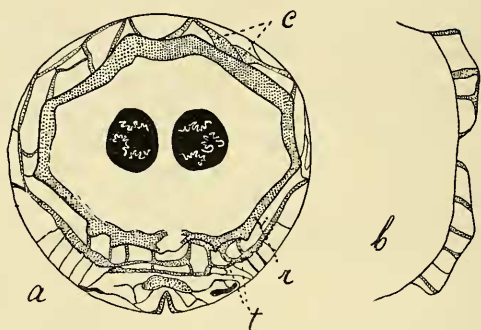


Fig. 3. *Mesembrina meridiana* L. ; a posterior end: r rim, its dark coloured distal end dotted, the lighter coloured, obliquely running part with longitudinal chitin thickenings (t), ($\times 13$), b rim, viewed from the ventral side ($\times 13$).

15 lobes counted on the prothoracic spiracles. No pupal breathing-horns present. On the left side of the one puparium available, a whitish coloured, round spot on the posterior border of the first abdominal segment, where perhaps a horn ought to break through. The large posterior spiracles cut by the horizontal diameter of the posterior end. The distance between them less than a half time their horizontal diameter. The stigmal plates black. Either spiracle with 3 long, very sinuous slits. Each slit showing from 5 to 7 turnings. The scars not perceptible. The posterior end covered by an extremely fine, inconspicuous, reticular structure.

The large size, the truncated posterior end with the protruding rim, and the large spiracles with the long, very sinuous slits, are the most conspicuous characteristics of the puparium of this species.

The female lays one single, large egg, in the excrements of horses and cattle. The egg is 4.5 mm. long and contains a completely formed larva. The larva emerges almost immediately after the egg has been laid. It is coprophagous and develops quickly (Séguy 1923).

***Muscina stabulans* Fall.**

Fig. 4.

Puparia found in Amsterdam, further details not recorded.

Medium-sized : length from 6,5 to 7,5 mm., largest diameter circa 2,5 mm. Colour shiny reddish brown. Shape conspicuous by the suddenly rounded-off posterior end. The breadth suddenly narrowing from the first abdominal segment towards the anterior end, the sides of the abdominal segments almost parallel or slightly converging towards the posterior end. The posterior end without papillae, showing only two dark, very short, stigma-bearing protuberances. Segmentation

indicated by rows of very conspicuous, brown spots. In the middle of the dorsal side of the last segment a short, longitudinal row of a few spots. Dorsally on the anterior

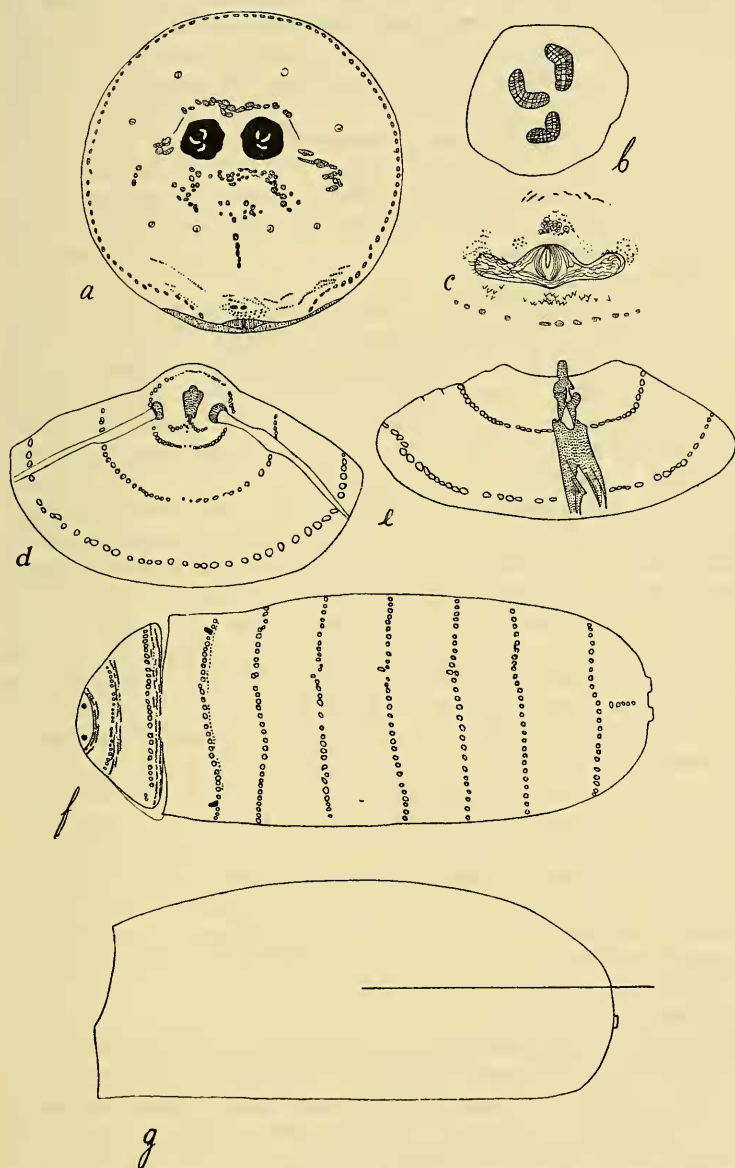


Fig. 4. *Muscina stabulans* Fall.: a posterior end ($\times 18$), b left posteriol spiracle ($\times 92$), c anus with surrounding border and spines ($\times 18$), d dorsal plate, pushed up by the emerging adult ($\times 18$), e ventral plate ($\times 18$), f puparium, dorsal view ($\times 10$), g puparium, lateral view with medoid horizontal line, schematic ($\times 10$).

borders only of the second and third thoracic segments, and the first two abdominal segments a few rows of very small spines, with their tops turned backward. No spines on the lateral sides, but here and there some brown spots. Ventrally behind the spots belts of spines, consisting of 5 to 7 rows. On the third and fourth segment moreover some rows of spines on the posterior borders. Most of them with their tops turned backward. The spines on the first abdominal segment very small, arranged in regular rows. Most spines on the other segments larger, some of them bifid, and located more irregularly. In and after the belts of spines also fragmentary rows of brown spots. The whole puparium finely transversely wrinkled. Cephalopharyngeal skeleton reaching well into the first abdominal segment.

The larval prothoracic spiracles visible as two dark spots, not or slightly protruding. Laterally on the posterior border of the first abdominal segment two small, dark coloured pupal breathing-horns, protruding upward. The posterior spiracles on two very short, cylindrical, parallel protuberances. The protuberances as well as the stigmal plates dark coloured, situated under the medio-horizontal line. The distance between the spiracles circa half their horizontal diameter. Either spiracle with 3 curved slits, which converge to the inner edge of the stigmal plate. Scar not perceptible. Round the spiracles groups of brown spots. Near the ventral edge some rows of small, inconspicuous spines. On one of the puparia examined, two dark spots this side of the anal opening. Neither papillae nor spots of tangled wrinkles on the posterior end, but 4 pairs of sensory hairs perceptible, each hair located in an inconspicuous, round, light-brown coloured spot. One of these pairs located above the spiracles, one pair on either side, the other two pairs under the spiracles. The anal opening, surrounded by a transverse elongated, dark border, on the ventral side of the last abdominal segment. The brown border widest round the anus, and somewhat constricted halfway the rounded ends. In front of the anus some rows of conspicuous spines, with their tops turned forward. On the other side of the anal-spot groups of small spines.

The way in which the puparium opens is a marked feature. The lateral, horizontal lines of dehiscence reach backward, (as in all *Anthomyinae*), as far as in the fore-part of the first abdominal segment, where both fork into an ascending and a descending branch. At the anterior end, however, these two horizontal lines do not divide the first thoracic segment into a dorsal and a ventral half, but meet along the ventral anterior border of this segment. (Fig. 4 d and e). So the first thoracic segment as a whole remains attached to the dorsal plate, which thus consists of the first thoracic segment, the

dorsal half of the second and third thoracic segments, and the dorsal half of the anterior border of the first abdominal segment. The ventral plate only consists of the ventral half of the second and third thoracic segments, and the ventral half of the anterior border of the first abdominal segment. The cephalopharyngeal skeleton lies on the ventral plate. A small, dark part, lying before the oral hooks, remains attached to the dorsal plate.

The puparia of this species are characterized by their large, broad, and suddenly rounded-off shape, their shiny, reddish brown colour, the rows of spots, the short pupal breathing-horns, the position and shape of the dark posterior spiracles with the curved slits, the 4 pairs of sensory hairs, and the peculiar way in which it opens.

Short descriptions of the maggot are made by Bouché (1834), Banks (1912), Portchinsky (1913), and some remarks about its cephalopharyngeal skeleton are made by Wahl (1914) and Keilin (1917).

Keilin (1917) gives a brief account of the observations about the habit of *Muscina stabulans* Fall., published by former authors. As the species was reared from maggots feeding on decomposing vegetable matter, excrements and manure, as well as from maggots feeding on caterpillars and pupae of *Lepidoptera*, *Tenthredinidae* and of *Galerucella luteola* Mull. (the elm-leaf beetle), it was now described as being saprophagous, and again as being parasitical. These observations being incomplete and often contradictory, we owe essential details about this species to Portchinsky (1913). The principal results of his investigations follow here, as they are cited by Keilin (1917). *Muscina stabulans* Fall. is found in our houses, though less frequently and in fewer numbers than the common house-fly. When going to oviposit the female often penetrates into sheltered corners; the eggs have even been found in a key-hole. The female may lay 160 eggs, which are scattered over the feeding matter. The young maggots first feed upon decomposing organic matter. At the end of the second larval stage already they begin to attack different larvae, which also live in the same feeding matter, for instance those of the house-fly or of *Hydrotæa dentipes* Fabr. In the third stage the larvae of *M. stabulans* Fall. are entirely carnivorous and very voracious. Brought together with maggots of *Polietes albolineata* Fall., they are destroyed in their turn. The ability to oviposit on victuals, which are kept in dark and closed places, is the reason that this fly is a frequent cause of intestinal myiasis of man. Séguy (1924) records the occurrence of this species in the nests of swallows. Sorauer (1932) mentions that the imagines are reared from toad-stools, fruits, gherkins, turnip-tops, decaying potatoes, pea-pods, radish, the end-stalks of *Cirsium discolor*, beets,

and sugar-beets, to which the maggots may cause considerable damage.

So the larvae of *Muscina stabulans* Fall. may be saprophagous or coprophagous, phytophagous or carnivorous. According to Séguy (1924) the maggots may during their entire development keep to one of these diets. A maggot which has begun its life as a scavenger may become phytophagous or carnivorous in the later larval stages. A larva however, which starts as a carnivore cannot change afterwards to different nourishment. Concerning their parasitical inclination, mentioned by various authors, the following is remarked by Keilin (1917). The females, like those of many Diptera, are often attracted by the dead bodies of larvae, pupae or adult insects, on which they oviposit. The young larvae of *Muscina stabulans* Fall. first live saprophagously, next they become carnivorous, destroying other larvae and finally attack live caterpillars or pupae. They suck out the contents of their prey and, when full-grown, pupate in or near the empty skin of their victim. This reminds us of the pupation of a real parasite.

Séguy (1923) records that the eggs hatch within 2 days. After 15 to 20 days the full-grown maggot accumulates the vegetable detritus in the form of a cocoon, in which the transformation into a pupa takes place. There may be 10 successive generations a year.

Morellia aenescens Rob. Desv.

Fig. 5.

Puparium found in alluvial deposit of river Rhine near Herwen.

Small: length 5 mm., largest diameter 2 mm. Shape like that of *M. hortorum* Fall. (see fig. 6d), but more dorsoventrally flattened. Colour yellowish grey, encircled by darker belts at the junctions of the segments. On the thoracic segments the skin of these belts dark coloured. The dark border of the skin between the third thoracic and first abdominal segment beset with spines. On the following borders the dark colour is only owing to a number of large, dark, rather blunt spines. These spines with their tops turned backward; from 5 to 7 rows in each belt. In front of these rows, from 1 to 3 rows of small, flat spines, with their tops turned forward. The spines as numerous on the dorsal as on the ventral side; on the lateral sides the spines somewhat fewer in number. The spines between the seventh and eighth segment on the dorsal side small and inconspicuous, on the ventral side, however, clear and very numerous. The spines in front of the anus with their tops turned forward. Round and under the anus a large number of spines, with their tops

turned backward. The whole skin covered by a chitinous reticular structure (see p and q on fig. 5). The skin hard and firm. The cephalopharyngeal skeleton reaching to the anterior border of the second abdominal segment. The circular line of dehiscence running on the posterior half of the first abdominal segment.

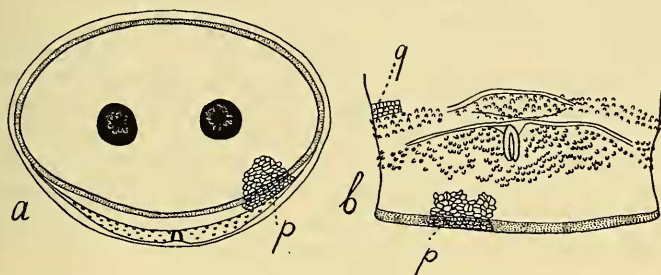


Fig. 5. *Morellia aenescens* Rob. Desv.; a posterior end ($\times 23$), b last segment, ventral view ($\times 23$), p and q reticular structure of the skin.

The prothoracic spiracles not perceptible. No pupal breathing horns. The posterior spiracles cut by the horizontal diameter of the posterior end. The distance between them a little more than one and a half times their horizontal diameter. The stigmal plates black. Faint traces of sinuous slits scarcely perceptible.

The puparium of *M. aenescens* Rob. Desv. may be distinguished from that of *M. hortorum* Fall. by its smaller size, its delicate appearance, and by the larger distance between the posterior spiracles.

***Morellia hortorum* Fall.**

Fig. 6.

Larva found in the Netherlands, not further specified.

Puparium medium-sized: length 7 mm., largest diameter 2 mm. Colour yellowish grey with blackish brown, heavy wrinkles at the junction of most segments. These wrinkles very heavy on the ventral side between the first 6 and between the last 3 segments. As the dorsal part of the thoracic segments is lacking on the one puparium available, we cannot say with certainty that the wrinkles continue on this part. The dark wrinkle between the first and second abdominal segment completely encircling the puparium, the wrinkle between the second and third abdominal segments ending before the middle of the dorsal side, those between the last abdominal segments ending on the lateral sides. The ventral part of the eighth segment somewhat darker coloured than the rest of the puparium. The posterior spiracles black.

Shape of the puparium very conspicuous by the posterior end, which is obliquely truncated, very abruptly, and encircled by a thin, protruding rim. The stigmal area, enclosed by this rim, almost flat, showing only a slight swelling between the two protruding spiracles. The ventral side of the last segment considerably longer than the dorsal side. The whole puparium somewhat dorsoventrally flattened. Segmentation distinct.

Encircling the puparium belts of spines, situated partly on the posterior border, partly on the anterior border of the segments. The thick chitin wrinkles also beset with spines. The whole skin covered with a reticular structure, as is sketched in fig. 6 c. This structure less conspicuous on the sides of the last segment and at the junctions of the segments. The circular line of dehiscence running on the posterior border of the first abdominal segment.

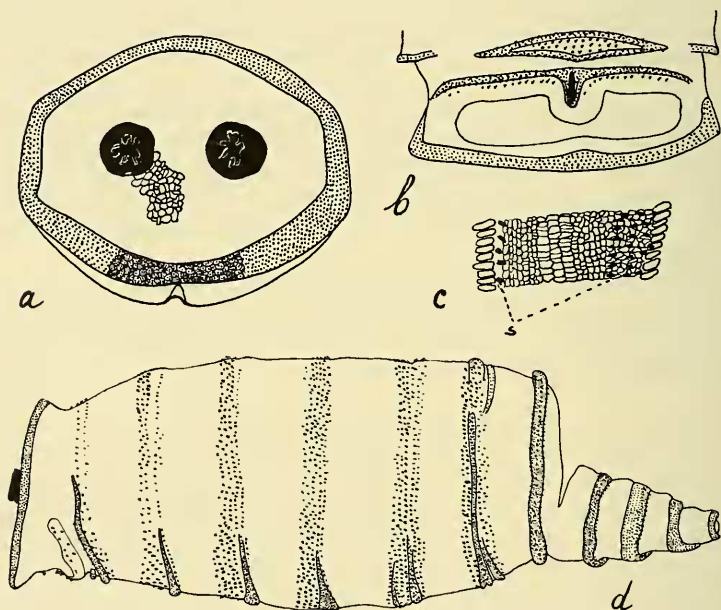


Fig. 6. *Morellia hortorum* Fall.; a posterior end ($\times 30$), b ventral side of the last segment ($\times 30$), c chitinous network on the skin, s spines ($\times 30$), d puparium, viewed from the side ($\times 13$).

No pupal breathing horns present on the part of the puparium examined. As a large part of the first abdominal segment is lacking on the one specimen available, the statement that pupal breathing horns are lacking wants confirmation by the investigation of a complete specimen. The posterior spiracles situated on two black, parallel, short protuberances, cut by the horizontal diameter of the posterior

end. The distance between the spiracles somewhat larger than their horizontal diameter. Only fragments of the sinuous slits faintly perceptible on the black stigmal plates. No papillae on the posterior end, which, like the whole puparium, is covered by a chitinous reticular structure. A lozenge-shaped wrinkle in front of the anal opening.

The puparium of the two species of *Morellia* examined are conspicuous by their shape and colour, and by the reticular structure of the skin.

Larvae of *M. hortorum* Fall. were found in cow-dung.

Howard (1900) gives a drawing of the puparium of *M. micans* Macq., an american species, which breeds in human excrements. This puparium apparently shows the same peculiarities in shape.

***Haematobia stimulans* Mg.**

Fig. 7.

Puparium found in alluvial deposit of river Rhine near Herwen.

Small: length circa 5 mm., largest diameter 2 mm. Colour reddish brown, the pupal breathing horns and posterior spiracles black. Shape normal, almost equally rounded off at the anterior and posterior end. The sides parallel. Segmentation distinct. At the junctions of the segments rows of spots. These rows between the abdominal segments on the ventral side branched off into 2 rows, enclosing fusiform areas, which show long, irregularly shaped chitin thickenings. Moreover, some short, broken, transverse rows of spots halfway the segments on the ventral side. On the lateral sides some spots, arranged longitudinally. On the dorsal side of the last segment also 2 short longitudinal rows of spots. The skin on the borders of the segments finely transversely wrinkled. The rest of the surface covered with small, granular chitin-thickenings.

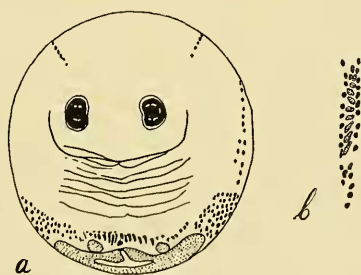


Fig. 7. *Haematobia stimulans* Mg.: a posterior end ($\times 23$), b spots on the ventral side, at the junctions of the segments ($\times 23$).

The dorsal part in front of the circular line of dehiscence, on which the larval prothoracic spiracles, lacking on the one puparium available. The dark pupal breathing-horns, lying at the junction of the first and second abdominal segment, small, thin, and protruding forward. The posterior spiracles kidney-shaped, lying on short, dark coloured, parallel protuberances, encircled at their bases by a lighter coloured ring. The distance between them somewhat more than two and a half times their horizontal diameter. The stigmal plates black. The slits slightly curved and lying at right angles to each other. Each horizontal slit showing 1 or 2 slight constrictions. The vertical slits not so clearly visible on the one specimen examined. The scars not perceptible. No papillae on the posterior end. 2 round, brown chitin spots at this side of the anal opening. The anal opening encircled by a number of conspicuous, irregularly shaped chitin-thickenings.

The small, inconspicuous pupal breathing-horns, the kidney-shaped posterior spiracles, the large distance between them, and the position of the slightly curved slits are the most conspicuous characteristics of the puparium of this species.

Séguy (1924) gives a drawing of the posterior spiracles of the larva. Here the slits are S-shaped. The eggs are laid singly so that the larvae are hard to detect. The imagines suck the blood of men and cattle.

Lyperosia irritans L.

Fig. 8.

Puparia found in alluvial deposit of river Rhine near Herwen.

Small: length circa 3.5 mm., Largest diameter 1.5 mm.

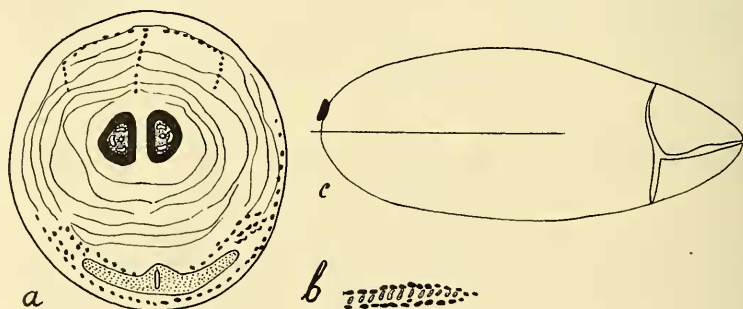


Fig. 8. *Lyperosia irritans* L.; a posterior end ($\times 30$), b spots on the ventral side, at the junctions of the segments ($\times 30$), c puparium viewed from the lateral side, with medio-horizontal line, schematic ($\times 15$).

Colour light brown, posterior spiracles black. Shape normal : the sides almost parallel, the posterior end rounded off. Segmentation indicated by rows of brown spots. Each of these rows ventrally branched off into two rows, enclosing a row of elongated, brown spots. Moreover, on the ventral side halfway each abdominal segment a transverse, broken row of brown spots. The skin finely transversely wrinkled. The cephalopharyngeal skeleton reaching well into the second abdominal segment.

The larval prothoracic spiracles hardly perceptible. No pupal breathing-horns discernable on the two puparia available. The posterior spiracles on black, somewhat diverging protuberances, situated in the dorsal part of the posterior end, a short distance above the medio-horizontal plane. The distance between the spiracles less than half their horizontal diameter. The stigmal plates D-shaped, their flat sides turned to each other. The slightly curved slits forming almost half a circle on either plate. The peritremata black. On one of the 2 puparia examined the stigmal plates black, but on the other specimen lighter coloured. No papillae on the posterior end. Round the anal opening a transverse-elongated, brown border.

The puparia of this species are characterized by the shape of the posterior spiracles, the small distance between them, and the position of the slightly curved slits.

The female as well as the male flies suck the blood of cattle and men. The eggs are laid singly.

Subfamily *Anthomyiinae*.

Pegomyia bicolor Wied.

Fig. 9.

Larva found in *Polygonum persicaria* L., the Netherlands.

Only one puparium present, from which the dorsal part of the thoracic segments is broken off. Small : length 5 mm., largest diameter circa 1,3 mm. Colour shiny reddish brown, the stigma-bearing protuberances on the posterior end dark. Shape normal : suddenly narrowing towards the anterior end, rounded at the posterior end. Segmentation indistinct. Encircling the puparium 8 belts of spines, situated on the abdominal segments. Most belts on the dorsal side consisting of 7 to 9 rows of spines, those on the ventral side being wider. Laterally the belts may be broken. On the dorsal side of the eighth segment the spines situated in 16 very irregular rows. Most spines situated on the anterior border of the segments and with their tops turned backward, the others, on the posterior border of the segments, with their tops turned forward. The spines on the first two abdominal segments

larger than those on the following segments. At the junctions of most abdominal segments a row of spots. The whole skin finely transversely wrinkled. On the ventro-lateral sides of the second and third thoracic segments dark dots, to which wrinkles converge. The cephalopharyngeal skeleton reaching well into the first abdominal segment.



Fig. 9. *Pegomyia bicolor* Wied.; posterior end ($\times 30$).

The posterior spiracles on conical, somewhat diverging protuberances. These protuberances short, dark coloured. The distance between the spiracles circa one and a half times their horizontal diameter. The slits hardly perceptible. Only their distal ends clear, protruding somewhat beyond the peritreme. On the one puparium examined on the left spiracle 3, on the right spiracle only 2 slits visible, converging to the upper inner edge of the stigmal plate. Scar indistinct. No papillae on the posterior end, but 6 pairs of spots, consisting of tangled chitin wrinkles. These spots arranged in a circle round the posterior spiracles. The middle pair of the 3 pairs on the dorsal half smaller than the two adjacent pairs. The two pairs situated under the spiracles close together. Small spines, arranged in a large number of sinuous rows above the spiracles. A few rows of spines under the spiracles, and laterally somewhat lower down. The anal opening encircled by a border, which is somewhat darker coloured than the rest of the puparium.

The most characteristic features of the puparium of this species are the elongated slits, protruding beyond the dark peritreme, and the 6 pairs of spots around the spiracles.

Concerning the figure of the posterior end of the larva, given by Cameron (1914), I might suggest that the posterior end is sketched by him, viewed obliquely from the ventral side. The lobes, mentioned by this author, are not visible any longer on the posterior end of the puparium.

The larvae of *P. bicolor* mine the leaves of various species of *Rumex* and *Polygonum*.

Pegomyia hyoscyami hyoscyami Panz.,
Pegomyia hyoscyami Panz. var. *betæ* Curtis.
Pegomyia hyoscyami Panz. var. *chenopodii* Rond.
 and
Pegomyia hyoscyami Panz. var. *silenes* Hering.

Fig. 10 and 11.

It seems advisable here to begin with some remarks concerning the biology and the systematical relationship of these flies, as the investigation of the puparia may contribute to the extension of our knowledge of this question.

The maggots of *P. hyoscyami* Panz. are found mining the leaves of a large number of plants. The following host plants are mentioned in the comprehensive paper by Bremer and Kaufmann (1931): a *Chenopodiaceae*: *Chenopodium album* L., *C. murale* L., *Atriplex hortense* L., *A. patulum* L., *Spinacia oleracea* L., *Beta triggya*, *Beta vulgaris* L. (var. *rubra*; *altissima* Rossig; *esculenta* Gurke), *Beta vulgaris* var. *hybrida* (*Beta cicla* L.) and *Amarantus retroflexus* L., b *Solanaceae*: *Hyoscyamus niger* L., *Atropa belladonna* L., *Datura stramonium* L. and *Solanum dulcamara* L., c *Caryophyllaceae*: *Silene vulgaris* Garcke = *Silene inflata* Smith, *Stellaria media* (L.) Cyrillo, *Silene spec.*, and *Silene maritima* With. The cases in which *P. hyoscyami* is mentioned feeding on *Rosaceae*, *Compositae* and *Polygonaceae*, to these authors appear to be doubtful. According to Jablonowski (1909) the larvae may complete their development on manure or humous matter, and also on decaying leaves of any kind if the natural food plants fail.

The eggs are laid on the under surface of the leaves, in groups of 3 to 5. Usually there are but 3 or 4 groups of eggs on a single leaf, but for instance Frost (1924) relates how he saw in the early spring small spinach leaves so thickly covered with eggs that they had a whitish appearance from below. The incubation period of the eggs has been noticed as varying from 3 to 8 days. A very detailed description of the way in which the mine is made is given by Frost. The larvae from a single group of eggs enter the leaf by separate holes, but almost immediately after they have entered, the channels made by them coalesce to form a single mine. Thus, feeding side by side, they produce a short, linear mine. In approximately a day the larvae separate, moving in different directions, producing a blotch mine. Fresh mines are greenish in colour. The frass is scattered about the mine in small, green pellets. On *Beta vulgaris* L. and *Chenopodium album* L. the mines become brownish when dry, but on *Amarantus retroflexus* L. they become whitish. On plants with thick leaves, such as beets and spinach, the mine alternates from the lower to the upper surface and is seldom visible from both surfaces

at the same time, except towards its completion. On the plants with thinner leaves, as *Chenopodium album* L. and *Amarantus retroflexus* L., the mine is visible from both sides. If the leaves are small and fail to furnish enough food, the larvae abandon their mines to form new ones in fresh leaves. After 2 to 3 weeks they are full-grown. Pupation usually occurs in the ground or under dried leaves, occasionally in the mine. After 8 to 20 days the flies emerge. In northern Europe 2 or 3 generations hatch each year, in warmer regions probably more generations occur. Hibernation mainly takes place in the pupal stage.

Considering the large number of feeding plants, belonging to 3 different plant families, the question arises, whether we are dealing with really one single species of flies, occurring on all these plants, or with more than one species, or with varieties, which are in the imaginal stage morphologically hard to discriminate but differ in the choice of their host plant. In the extensive literature concerning these flies (v. the bibliography of Bremer and Kaufmann) various views are held, for the greater part loosely founded, and the nomenclature is rather confusing. In 1737 Réaumur described the larva of *Pegomyia hyoscyami*, found by him in *Hyoscyamus niger* L. The detailed description of the adult fly is owing to Panzer in 1809. So the flies, which in the larval stage feed in *Hyoscyamus niger* L., or rather, those feeding in *Solanaceae* (see below), have to be considered as the typical form. Therefore I might propose to call these flies *Pegomyia hyoscyami hyoscyami* Panz. as Prof. de Meijere kindly suggested to me, rather than calling them *P. hyoscyami solani*, as Bremer and Kaufmann propose. It does not serve our purpose to give examples of the nomenclature, used by various authors. As throughout this paper the nomenclature of Karl (1928) is followed, only the classification used by this author follows here:

- | | |
|---|---|
| <i>Pegomyia hyoscyami</i> Panz. | (typical form in <i>Solanaceae</i>). |
| " " " | var. <i>betae</i> (Curtis) 1847, from <i>Beta vulgaris</i> L. |
| " " " | var. <i>chenopodii</i> Rond. 1866, from <i>Chenopodium</i> and <i>Atriplex</i> species. |
| " " " | var. <i>spinaciae</i> Holmgren 1880, from <i>Spinacia oleracea</i> L. |
| " " " | var. <i>silenes</i> Hering 1924 from <i>Silene vulgaris</i> Garcke. |

After the description of the puparia it will appear in how far I can agree with his nomenclature.

After the "Muscidae" by Karl (1928) had been published, Hering (1930) pointed out the existence of another variety of *P. hyoscyami*, which was reared in southern Russia from

Hyoscyamus niger L. and *Datura stramonium* L. The imagines of this variety, called by him *P. hyoscyami meridiana*, are only in the male discernable from the other *P. hyoscyami* reared from these plants, by the orbits touching each other. As there is no material of this variety available, its ground for existence cannot be discussed here.

Various authors tried, in different ways, to get a clearer insight into the relationship of these flies.

According to Bremer and Kaufmann it seems as if the imagines, reared from *Solanaceae*, are covered with bristles, which are shorter and less in number than on the imagines, which have been feeding on *Chenopodiaceae*. Yet reliable morphological characteristics of the imagines could not be found. The colour is the only feature by which the imagines, reared from different plants may be distinguished. So Bremer and Kaufmann composed a table, in which they indicated the colours of the thorax, abdomen, legs and antennae of imagines, reared from *Spinacia oleracea* L., *Beta*, *Chenopodium* and *Atriplex*, *Hyoscyamus niger* L., *Datura stramonium* L., *Silene* and *Atropa belladonna* L. Generally the flies reared from *Chenopodiaceae* are darker coloured than the typical *P. hyoscyami* Panz., reared from *Solanaceae*.

Moreover, attempts have been made to solve the question by breeding experiments. Cameron (1914) put a large number of fertilized females, reared from larvae which had been feeding on belladonna leaves, in breeding cages, provided with fresh mangold plants. In not a single instance eggs were deposited. Nor were any eggs laid on belladonna by fertilized females which were reared from mangold. Cameron, though realizing the fact that his experiments were insufficient for drawing a general conclusion, suggested the possibility that *Pegomyia hyoscyami* Panz. might be divided into at least two "biologic" species, one of which would be confined to the *Chenopodiaceae*, the other to the *Solanaceae*. Similar, but more extensive breeding experiments by Bremer and Kaufmann led to the same conclusions. No real biologic difference could be shown between the specimens of *Pegomyia hyoscyami* living in the various *Chenopodiaceae* or between those, feeding in various *Solanaceae* neither by breeding experiments, nor by crossing experiments. Yet it may be mentioned that apparently the flies breeding in *Chenopodiaceae* prefer *Beta*, and the flies breeding in *Solanaceae* prefer *Hyoscyamus niger* L.

While reading these experiments the question arises whether the varieties *betae* Curtis, *chenopodii* Rond., and *spinaciae* Holmgren, mentioned by Karl, can be maintained.

Hering (1924) established the mining of *Pegomyia hyoscyami* Panz. in *Silene vulgaris* Garcke. On account of slight deviations of the cephalopharyngeal skeleton of the larva, he

called the fly *P. hyoscyami* Panz. subspecies *silenes*.

Suire (1926) experimented with a fly, reared from *Silene inflata* Sm. (synonym of *S. vulgaris* Garcke). In captivity eggs were deposited only on *Silene inflata* Sm., and not on *Beta* and *Chenopodium*. He calls these flies, together with specimens, reared from spinach, *P. hyoscyami* Panz. var. *nigricornis* Strobl. According to Séguy this variety is characterized in the adult stage by the black antennae and palpa. It is still open to doubt whether *P. hyoscyami* Panz. var. *silenes* Hering is identical with *P. hyoscyami* Panz. var. *nigricornis* Strobl. Karl mentions only the "var." *silenes* Hering.

By the side of the investigation of the imagines and breeding experiments, the investigation of the larvae and puparia, reared from various feeding plants, is a third way, in which differences between the subspecies or varieties may appear. Unfortunately Kemner (1925) and Cameron (1914) do not mention the variety of the larvae, sketched by them. From the text it seems most probable that the larva, sketched by Kemner, is var. *betae*. We owe detailed descriptions and sketches of larvae, reared from *Chenopodium album* L., *Beta vulgaris* L. and *Silene vulgaris* Garcke, to Mrs. de Vos-de Wilde (1935). On account of differences in the cephalopharyngeal skeleton of the larvae this author arrives at the conclusion that *P. hyoscyami* Panz. var. *silenes* Hering has to be considered as a species apart.

According to Kemner the number of lobes on the prothoracic spiracles on the larvae, reared from *Beta*, varies from 6 to 10. Frost counts from 7 to 10 lobes. Mrs. de Vos-de Wilde observes on most larvae, reared from *Beta*, 6 or 7 lobes, and counts 10 in one case only. On most larvae found on *Chenopodium album*, she counts 11 lobes, except on one specimen, where the number was 10. She remarks that this fact justifies the distinction between the biological races of *chenopodii* and *betae*. Differences concerning the posterior ends of these larvae are not mentioned by her.

I quite agree with this author as regards the opinion that it will not be possible to solve these questions definitely until the larvae and puparia, reared from the various feeding-plants, will be thoroughly investigated.

I was so fortunate as to examine from the collection of Prof. de Meijere 6 puparia of *P. hyoscyami hyoscyami* Panz., reared from *Hyoscyamus niger* L., 2 puparia reared from *Atropa belladonna* L., and 2 puparia, found in the alluvial deposit of the river Rhine. The flies, emerged from these 2 puparia, were identified by Prof. de Meijere as also belonging to *P. hyoscyami hyoscyami* Panz. There were, besides, 3 puparia reared from *Chenopodium album* L., and 1 puparium reared from *Silene vulgaris* Garcke, collected by Dr. Stary

in Czechoslovakia. Mr. Schoevers, substitute director of the "Plantenziektenkundigen Dienst" in Wageningen was so kind as to send us on request 5 puparia, reared from *Beta*.

***Pegomyia hyoscyami hyoscyami* Panz.**

Fig. 10.

2 Puparia found in alluvial deposit of river Rhine near Herwen, 6 puparia reared from *Hyoscyamus niger* L. and 2 puparia reared from *Atropa belladonna* L.

The specimens examined 5 or 5,5 mm. long, their largest diameter circa 2 mm. Colour light brown or reddish brown, the anterior and posterior spiracles darker coloured. Shape normal. The ventral side flattened, the dorsal side convex. A slight constriction in the second abdominal segment. Posterior end rather blunt, rounded, showing two cylindrical, short stigma-bearing protuberances. Segmentation indistinct. On the dorsal and ventral side 8 belts of small, inconspicuous spines. Most spines situated on the anterior borders of the abdominal segments, the others on the posterior borders of the preceding segments. The first 4 belts entirely encircling the puparium, the others broken on the lateral sides or only consisting there of a few curved rows. The belts wider on the ventral side than on the dorsal side, divided there into two parallel belts. At the junctions of the segments transverse rows of elongated spots. From the fifth abdominal segment onwards each row on the lateral sides branched off into two rows, which meet again somewhat farther on, thus enclosing a fusiform area. The first thoracic segment coarsely longitudinally wrinkled. The rest of the puparium finely transversely wrinkled, rather more irregularly on the last segment. The cephalopharyngeal skeleton reaching well into the first abdominal segment.

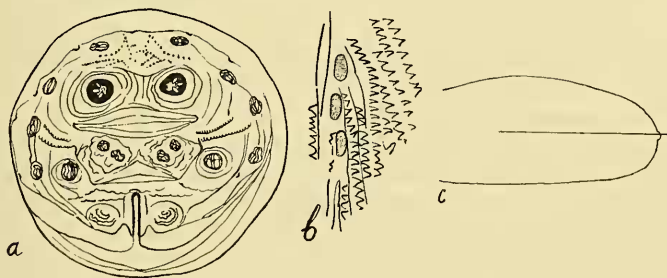


Fig. 10. *Pegomyia hyoscyami hyoscyami* Panz.; a posterior end ($\times 23$), b fragment of belt of spines with spots ($\times 115$), c schematic sketch of the puparium viewed from the side, with medio-horizontal line ($\times 6,5$).

The larval prothoracic spiracles perceptible as small, black protrusions, palmate, with 6 to 8 lobes. The black posterior

spiracles on short, cylindrical, parallel protuberances. These dark brown protuberances on the same height as the medio-horizontal line. The distance between the spiracles one and a half times or twice their own horizontal diameter. Either spiracle showing 3 short, converging slits on the dark coloured stigmal plate. The middle lobe horizontal, the other two at acute angles. Scar indistinct, situated in the middle of the inner edge. Peritreme black, broad. No real papillae on the posterior end, but 8 pairs of circular, rather inconspicuous spots, sometimes slightly raised, consisting of tangled wrinkles. In the centre of most spots one dark coloured, short hair. The 2 small pairs of spots, lying under the spiracles, on some specimens scarcely perceptible between the thick chitin wrinkles. The spots situated near the long, slit-like anal opening often very inconspicuous. Above the spiracles and on the sides some rows of small, inconspicuous spines.

The puparia, reared from *Hyoscyamus niger* L. and from *Atropa belladonna* L. show exactly the same features as those, which were found in the alluvial deposit. So the investigation of these puparia supports the supposition that the flies, breeding in the various *Solanaceae* mentioned here, are identical.

The puparia of *P. hyoscyami hyoscyami* Panz. are characterized by the shape of the black posterior spiracles, which are situated on short, cylindrical protuberances, and the 8 pairs of wrinkled spots on the posterior end.

Pegomyia hyoscyami Panz. var. *betae* Curtis.

Puparia put at our disposal by Mr. Schoevers, substitute director of the Plantenziektenkundigen Dienst in Wageningen.

These puparia very similar to those of the typical form of *P. hyoscyami* Panz. The shape and the belts of spines are quite identical. The colour however is somewhat lighter. The larval prothoracic spiracles are small, so that the number of lobes could not be stated.

The posterior end is also very much like that of *P. hyoscyami hyoscyami* Panz. There are 6 pairs of slightly raised papillae and 2 pairs of small, wrinkled spots, situated farther down under the posterior spiracles. As the so-called "wrinkled spots" on the typical form are sometimes also slightly raised this is not a real difference, as their position is quite the same. The posterior spiracles are also identical; they are, however, not quite so dark. The distance between them varies here from once to one and a half times their horizontal diameter. There are a few more spines, colourless and small, scattered over the posterior end.

***Pegomyia hyoscyami* Panz. var. *chenopodii* Rond.**

Fig. 11.

Larvae found in *Chenopodium album* L., Amsterdam.

Puparia small, smaller than the two specimens of *P. hyoscyami hyoscyami* Panz. Length 4 mm., largest diameter 1.3 mm. Colour light or dark brown, on some specimens still darker at the anterior and posterior end. Shape normal. Sides of the first abdominal segments parallel, tapering towards the posterior end, on which two short stigma-bearing protuberances and some scarcely perceptible papillae. Posterior end flat or slightly rounded. Segmentation distinct. On the anterior borders of the abdominal segments 7 or 8 belts of spines. On one of the two specimens examined these belts entirely encircling the puparium. On the other specimen no spines on the ventral side. On the dorsal side these belts consisting of 4 to 7 rows of spines. At either side of the puparium 3 longitudinal rows of slight hollowings-out. Blackish or light brown, somewhat raised spots microscopically perceptible there. The skin finely transversely wrinkled, the first and last segments more irregularly. The cephalopharyngeal skeleton reaching into the first abdominal segment.

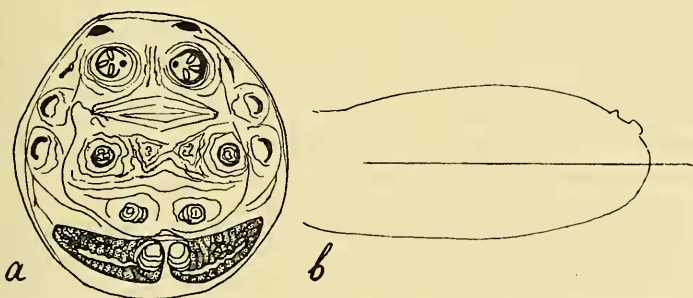


Fig. 11. *Pegomyia hyoscyami* Panz. var. *chenopodii* Rond.; a posterior end ($\times 34$), b schematic sketch of the puparium viewed from the side, with medio-horizontal line ($\times 13$).

The prothoracic spiracles showing 8 oval lobes. The posterior spiracles on cylindrical, short, somewhat diverging protuberances, situated above the medio-horizontal plane. The distance between the spiracles somewhat larger than once their horizontal diameter. Either spiracle with 3 converging slits. Scar situated in the middle of the inner edge. The middle slit horizontal or slightly turned upward to the scar. The other two at acute angles. 7 pairs of broad, slightly raised papillae on the posterior end. The middle of the 3 pairs of papillae on the dorsal half small, sometimes hardly perceptible. On the ventral half 2 pairs arranged in a horizontal row.

Near the median line 2 or 4 small, wrinkled spots. Lower down another pair of papillae, and the lowest pair situated on the lobes at either side of the slit-like anal opening. At the right and left side of the anal opening a dark-coloured, wrinkled, transverse-elongated border. This border only on one of the 3 puparia examined as conspicuous as on fig. 11.

The most striking characteristics in which the puparia of *P. hyoscyami chenopodii* differ from those of the typical *P. hyoscyami* are the diverging, lighter coloured stigma-bearing protuberances, their position high above the medio-horizontal line, the shorter distance between the spiracles, and the distinct papillae.

On account of these pupal characteristics it seems to me well-founded to consider *P. hyoscyami chenopodii* Rond. a variety, which is not identical with *P. hyoscyami betae* Curtis. The adult flies of these two varieties are hardly distinguishable if at all, as appears from the table, composed by Bremer and Kaufmann. Their colours are, for a great deal, quite identical, and may show only on some specimens gradual differences.

Pegomyia hyoscyami Panz. var. *silenes* Hering.

Larva found in *Silene vulgaris* Garcke, collected by Stary in Czechoslovakia.

The puparium of this variety is identical with that of *P. hyoscyami hyoscyami* Panz. as for the colour and shape, the belts of spines, the number of lobes on the larval prothoracic spiracles, as well as the appearance of the posterior end with the dark coloured spiracles, the long, slit-like anal opening and the 8 pairs of wrinkled spots between the thick chitin wrinkles.

Yet this variety *silenes* seems to be firmly established by Hering (1924) and borne out by Mrs. de Vos-de Wilde, on account of deviations in the cephalopharyngeal skeleton of the larva. The investigation of this skeleton does not form part of this treatise, as the details are not well discernable through the hardened and brown coloured larval skin. The assumption of *silenes* as a variety, which is not identical with var. *betae*, agrees with the following fact, mentioned by Bremer and Kaufmann. They found in *Silene vulgaris* Garcke, which grew abundantly on road-sides, not a single mine, though fields with heavily infected beets were in the immediate neighbourhood. May this in future be confirmed by further breeding experiments.

Summary of the results.

1. *P. hyoscyami hyoscyami* Panz., reared from *Hyoscyamus niger* L. and *Atropa belladonna* L., are also in the pupal stage entirely identical.

2. On account of the breeding experiments mentioned above, and the differences in colour of the imagines, it seems advisable to consider the flies, breeding in *Beta*, as a variety, called var. *betae*. The fact that the morphology of the puparia shows only slight differences of a quantitative nature from those of the typical form, needs not be contradictory to this.

3. The puparia, reared from *Chenopodium album* L. differ in the pupal stage from those of var *betae* Curtis, so that I might propose to maintain the var. *chenopodii* Rond. as a separate variety.

4. Material of var *spinaciae* Holmgren not being available, this variety cannot be discussed here.

5. The variety *silenes*, established by Hering (1924), does not show differences from the typical form in the pupal stage, except as regards the cephalopharyngeal skeleton, which is not treated here.

Pegomyia nigratarsis Zett.

Fig. 12.

Larvae found in *Rumex*, Amsterdam and Zwammerdam.

Small: length from 4,5 to 5,5 mm., largest diameter from 1,5 to 2 mm. Colour dark reddish brown, shiny. At either side of the anal opening a wide, dark coloured wrinkled border, enclosing a narrow, smooth space. Shape normal, the posterior end perpendicularly flattened, showing two stigma-bearing protuberances. Segmentation perceptible. Shiny borders alternating with almost dull belts, which are beset with extremely fine spines, arranged in straight rows. Those belts of spines entirely encircling the puparium. The skin finely transversely wrinkled. The cephalopharyngeal skeleton reaching well into the first abdominal segment.

The larval prothoracic spiracles with 22 elongated lobes, arranged in an elliptical ring, open at one side. De Meijere (1895) counted 23 lobes, Cameron (1914) from 16 to 25 lobes, and Mrs. de Vos-de Wilde (1935) from 19 tot 23 lobes. So their number varies greatly. The posterior spiracles on the top of diverging protuberances, which show a narrow distal end, so that they seem to consist of two parts. The position of the spiracles high above the medio-horizontal plane. The distance between the spiracles circa twice the horizontal diameter of either spiracle, the scar included. The 3 slits pointed at their distal ends, which are curved and protrude beyond the peritreme. The slits converging to the middle of the inner edges of the stigmal plates. Under the spiracles at either side 2 brown spots, with a dark dot in their centre. Besides 5 pairs of such spots, forming with the 2 pairs mentioned above, a circle round the spiracles. These 5 pairs of spots very inconspicuous and only found on one of the 3

specimens examined. At this side of the anus two lobes, which are best visible when the puparium is looked at from the ventral side, and hardly discernable when looked at as in figure 12.

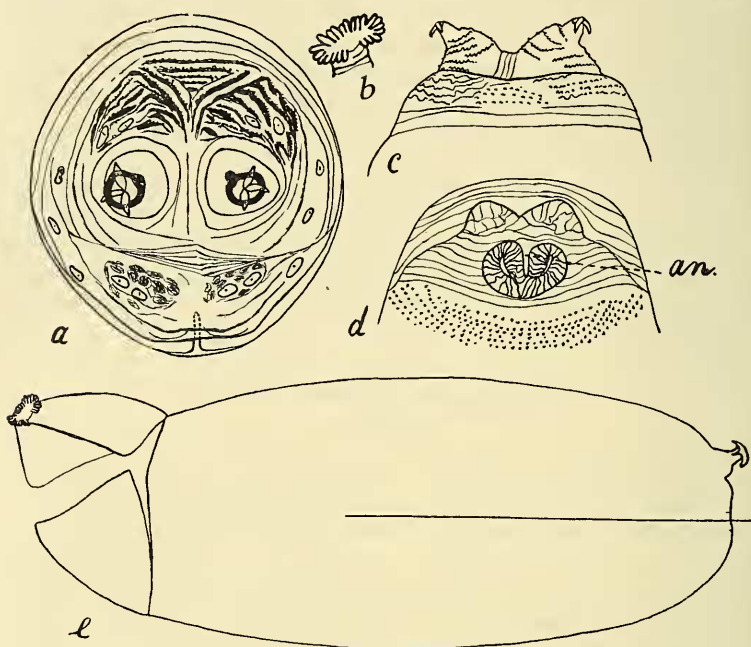


Fig. 12. *Pegomyia nigratarsis* Zett.: a posterior end ($\times 30$), b prothoracic spiracle ($\times 46$), c stigma-bearing protuberances from the dorsal side ($\times 30$), d posterior end from the ventral side, with anus an. ($\times 30$), e puparium viewed from the side, with the medio-horizontal line ($\times 18$).

The puparium of this species is characterized by the shape of the curved and protruding slits of the posterior spiracles and the absence of papillae on the posterior end. It shows a close resemblance to that of *P. bicolor* Wied, from which it may be distinguished by the larger distance between the papillae.

Cameron (1914) composed a table, by which the larvae of *P. hyoscyami* Panz., *P. bicolor* Wied, and *P. nigratarsis* Zett. may be identified. In this table the following is mentioned about the slits of the posterior spiracles of *P. nigratarsis* Zett.: "3 apertures, elongate oval, the largest dorsal, separate;" "twice the distance between the dorsal and the median as" "between the median and the ventral." In his sketch of the posterior end this striking position of the slits is clearly visible, just as on the sketch of the posterior end of the larva by Mrs. de Vos-de Wilde, who records that the dorsal slit is the largest of the three. On the puparia examined, however, I could not find this position. The 3 curved, acuminate slits

are equidistant, as appears clearly from the figure given above.

From the fleshy lobes, described and sketched on the posterior end of the larva by Mrs. de Vos-de Wilde (1935), only those situated above the anus are left on the puparium. The sinuous surface of the posterior end of the larva appears to be rounded off on the puparium.

According to Séguy the larvae live in the leaves of *Rumex acetosa* L., *R. acetosella* L., *R. crispus* L., *R. obtusifolius* L., *Patientia*, *Brassica* and *Atropa belladonna* L., where they cause blotch mines. The development is very similar to that of *P. hyoscyami* Panz.

Hylemyia lasciva Zett.

Fig. 13.

The one puparium present, found in alluvial deposit of river Rhine near Herwen.

The pieces in front of the circular line of dehiscence broken off. The length of the remaining part 4,5 mm. Largest diameter circa 1,8 mm. Colour yellowish brown. The puparium widest on the third abdominal segment, narrowing towards either end. The posterior end perpendicularly truncated, with a protruding rim. Segmentation indistinct. Encircling the puparium some rows of spots, which are broken on the ventral side. Behind these spots on the dorsal and ventral sides belts of very small, pointed spines. These spines on the dorsal side arranged in small, straight groups of 5 together, in 3 to 7 rows, and on the ventral side arranged more irregularly. The spines on the anterior border of the third and fourth segment with their tops toward the anterior end, on the following segments with their tops turned backward. The skin finely transversely wrinkled.

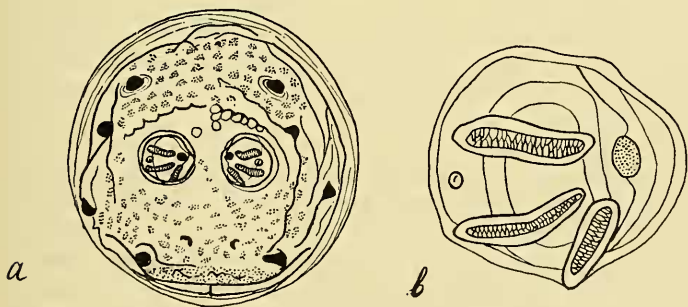


Fig. 13. *Hylemyia lasciva* Zett.; a posterior end ($\times 34$).
b left posterior spiracle ($\times 172$).

The light-coloured posterior spiracles not rising above the rim, which encircles the middle part of the flat posterior end. The spiracles touching the horizontal diameter of the posterior end. The distance between them circa half their horizontal diameter. The slits elongated, faintly curved and slightly converging to the scar, which is situated in the middle of the inner edge of the stigmal plate. Between the dorsal and middle slit a small, round circle, with a dark hair in its centre. Round the posterior end 4 pairs of distinct papillae, 2 pairs of which are situated on the dorsal half and 2 pairs on the ventral half. Under the spiracles a fifth pair of very small papillae. Numerous brown chitin spots scattered over the surface of the posterior end. The slit-like anal opening on the ventral part of the eighth segment, in the centre of a small, light-coloured circle which is surrounded by a transverse-elongated dark border.

The puparia of this species are conspicuous by the slightly concave posterior end, the large spiracles with the slightly curved, elongated slits, and the 5 pairs of papillae.

Hylemyia nigrimana Mg.

Fig. 14.

Larva found in the Netherlands, special locality not recorded.

The one puparium examined small: length 5,5 mm., largest diameter 2 mm. Colour reddish brown. Shape normal, from the fifth abdominal segment onwards tapering to the last segment, which has parallel sides. The posterior end obliquely flattened, showing a number of papillae. The posterior spiracles only slightly protruding. Segmentation distinct. The skin partly covered by very small spines, scarcely perceptible. These minute spines on the first abdominal segments less in number than on the last segments. At the junctions of the segments rows of spots, encircling the puparium. Each row laterally branched off into 2 rows, thus enclosing a fusiform area. The whole puparium finely transversely wrinkled. The cephalopharyngeal skeleton reaching into the second abdominal segment.

The number of lobes on the larval prothoracic spiracles indistinct. The one specimen present abnormal, in so far as it shows only the left posterior spiracle well-developed. On the place of the right posterior spiracle only a blackish-brown spot, surrounded by a lighter brown border. Probably on a well-developed puparium, the distance between the spiracles will be less than once their horizontal diameter. Their position in the dorsal half of the posterior end. The stigmal plate large, with 3 long slits, converging to the scar, which is situated in the middle of the inner edge. The upper

and middle slits lying at acute angles. The middle and lower slit forming an angle of nearly 90 degrees. 3 pairs of papillae on the dorsal half of the posterior end, the middle pair small. Under the spiracles 3 pairs of papillae, arranged in an al-



Fig. 14. *Hylemyia nigrimana* Mg.; posterior end, p the undeveloped right spiracle, q place where the puparium was pierced ($\times 30$).

most horizontal row. 1 or 2 other papillae somewhat lower down. As the puparium was pierced at q when preparing the posterior end, it cannot be stated with certainty that there is only one papilla there, though this seems to be most probable. At either side of the anal opening another pair of papillae.

The large posterior spiracles and the large papillae on the posterior end (15 or 16 in number), are the most characteristic features of this puparium.

Hylemyia pilipyga Vill.

Fig. 15.

Puparia found in alluvial deposit of river Rhine near Herwen, and reared from *Brassica chinensis* L.

Medium-sized: length circa 6 mm., largest diameter 2 mm. Colour yellowish brown, the larval prothoracic spiracles, the papillae and the stigma-bearing protuberances on the posterior end dark brown. Puparium from the fifth abdominal segment onwards tapering to the small posterior end. The posterior end obliquely flattened. Segmentation rather indistinct. On the anterior border of the third thoracic segment 4 rows of very small spines. Encircling the first 6 abdominal segments belts of spines, broken in the middle of the sides. The sixth belt also broken on the dorsal side. Each belt widest on the ventral side, consisting of a few curved, broken rows of spines. Most spines with their tops towards the posterior end, situated on the anterior border of the segments. In front of these spines an often inconspicuous row of brown spots, and 1 or 2 rows of spines with their tops towards the anterior end. These spines situated on the posterior bor-

der of the preceding segments. On the last two abdominal segments spines only on the ventral side. The first thoracic segment "creased", the second segment heavily wrinkled, the rest of the puparium finely transversely wrinkled. The cephalopharyngeal skeleton reaching a little into the first abdominal segment.

Larval prothoracic spiracles black, with probably 12 lobes, arranged in groups of 7 and of 5 lobes. The posterior spiracles on two cylindrical, short, dark coloured protuberances. These protuberances almost parallel, situated not far above the horizontal diameter in the dorsal half of the posterior end. The distance between the spiracles circa one and a half times their horizontal diameter. Either spiracle with 3 wide lobes, lying at acute angles, and converging to the scar, which is very distinct, and situated at the upper inner edge of the stigmal plate. Mrs. de Vos-de Wilde (1935) describes the upper lobe as being longer than the two others. On the puparium however the 3 lobes are of the same length. One pair of papillae, situated under the spiracles, large and bifid. The pair next to this also large and conspicuous, but singular. Still more laterally another pair of smaller papillae, not present on all specimens. On only one of the two specimens examined, moreover, 3 pairs of papillae on the dorsal half and one pair at this side of the anal opening. Mrs. de Vos-de Wilde counted 7 pairs of papillae on the



Fig. 15. *Hylemyia pilipyga* Vill. ; a posterior end ($\times 25$), b idem, dorsal view ($\times 26,5$), c larval prothoracic spiracles ($\times 77$).

posterior end of the larva. Apparently 5 of these pairs do not always remain perceptible on the puparium.

The puparia of this species are characterized by the position of the posterior spiracles, and the 3 or 6 pairs of papillae on the posterior end, one pair of which is bifid.

The puparium of this species is very much like that of *Chortophila brassicae* Bouché. It may differ in the distance between the posterior spiracles, it being on *C. brassicae* Bouché somewhat smaller than on *C. pilipyga* Vill., and in the position of the slits of the posterior spiracles. Moreover the sur-

face of the last segment of *C. pilipyga* Vill. is less wrinkled than that of *C. brassicae* Bouché.

According to Séguy, Keilin reared the imago from a larva, living in a turnip. Prof. de Meijere reared the imago from a larva living in the upper end of the roots of *Brassica chinensis* L. The puparium showed exactly the same features as those, found in the alluvial deposit.

***Chortophila* (*Egeria*) *brassicae* Bouché**

Hylemyia brassicae Bouché

Fig. 16.

Puparia found in cabbage-barn. Noord-Scharwoude.

Medium-sized: length circa 6,5 mm., largest diameter circa 2,2 mm. Colour light-brown to brown, the stigma-bearing protrusions on the posterior end dark coloured. Shape normal, narrowing towards the anterior and towards the posterior end. Sides of the first 6 abdominal segments mostly parallel, only on some specimens tapering from the first to the last abdominal segment. Posterior end obliquely flattened, showing two very short stigma-bearing protuberances and a number of distinct papillae. Segmentation distinct. At the anterior end of each abdominal segment a narrow belt of spines, mostly preceded by a row of light-brown spots, more or less clear. The spines arranged in broken, curved rows. The belts broken on the sides, and widest on the ventral side,



Fig. 16. *Chortophila brassicae* Bouché; posterior end ($\times 30$).

consisting there of 3 to 7 rows of spines, while there are 2 to 4 rows on the dorsal side. On the last three abdominal segments spines only ventrally, on the dorsal side only a few spines or no spines at all. On the dorsal side these spines with their tops towards the posterior end, on the ventral side spines with their tops turned either way. At some distance in front of the rows of spots moreover 1 to 3 rows of small spines, with their tops towards the anterior end, situated on the posterior border of the abdominal segments.

Each row of brown spots at either side branched off into two rows, which join again somewhat farther on, thus enclosing at either side fusiform areas between the abdominal segments. At either side of each segment two slight hollowings-out, each showing, when magnified, a longitudinal, short row of small, brown spots. The skin of the puparium transversely wrinkled, the first thoracic segment and the last abdominal segment irregularly "creased". The cephalopharyngeal skeleton reaching into the first abdominal segment.

On the larval prothoracic spiracles 10 or 11 lobes discernable. (Smith, 1927, counts from 11 to 13 lobes). The posterior spiracles on very short, black, cylindrical protuberances, situated in the dorsal half of the posterior end, just above its horizontal diameter. The distance between the spiracles somewhat larger than once their horizontal diameter. Either spiracle with 3 wide slits, converging to the scar, which is situated inside the upper edge of the stigmal plate. The middle slit pointing obliquely upward towards the scar, the other two lying at angles of not quite 90 degrees. Peritrema thick, dark-coloured. Scar raised, distinct. Indications of 3 pairs of papillae sometimes perceptible between the chitin wrinkles of the posterior end. Under the spiracles near the median line one pair of large, bifid papillae. Farther from the median line a pair of large, singular papillae and still more laterally one pair of small, inconspicuous ones. At this side of the anal opening at the left and right side a brown, wrinkled spot, not perceptible on all specimens. The slit-like anal opening surrounded by a transverse-elongated, brown spot. Round and between the spiracles and papillae irregular chitin wrinkles.

Comparing the descriptions by various authors of the larva and puparium of *C. brassicae* there appear to be some differences with regard to the papillae, situated under the posterior spiracles.

Mrs. de Vos-de Wilde (1935) writes about the posterior end of the larva of *C. brassicae*: "Le dernier segment porte plusieurs tubercules saillants, sept paires bien comptées, dont deux paires au milieu sont très grandes et se trouvent l'une à côté de l'autre, au dessous des stigmates postérieurs. Chaque paire est plantée sur une éminence arrondie; les tubercules sont bifurqués, chez quelques-uns il y a même tendance à une trifurcation".

When comparing the corresponding figure in that publication fig. 12 with the figure given here, we notice that this author considers the two parts of what is named by me "one bifid papilla" as two single papillae, situated close together on a rounded swelling. Now it appears that each of these 4 "papillae" (according to Mrs. de Vos-de Wilde) may show two, even three small tops of their own. These "bifurcations of second order" were seen clearly also by me on one of

the four puparia examined. This explains that Mrs. de Vos-de Wilde mentions 2 pairs of bifurcated papillae, while I think to be justified in holding to my view that there is only one pair of bifid papillae, the tops of which may show some small tops "of second order". This view of mine is based upon the fact that the two large tops, situated at either side of the median line have a common base, which is very apparent when looking at the puparium with a pocket-lens. The pair of very small papillae, named p in the figure given here, was probably not perceptible on the one specimen of the larva of *C. brassicae* examined by Mrs. de Vos-de Wilde.

Bouché (1834) also appears to consider the 4 tops under the spiracles as 4 papillae, as he writes: "Der Afterabschnitt ist am Rande mit zehn Fleischspitzen besetzt, davon die 4 untern je Zwillinge bilden".

The description of the full-grown larva given by K. M. Smith (1927) seems to agree with the description of the puparium given above. He writes: "At the posterior end there is a caudal corona, consisting of 6 pairs of tubercles, while a seventh pair is situated ventrally near the anus. The outstanding feature of this corona is the pair of bifid or forked tubercles on the ventral rim of the last segment". This as well as his figure of the puparium, though incomplete, agrees with the description given above.

Sorauer (1932) copies a drawing of the posterior end of the larva after J. B. Smith. This figure shows very distinctly 6 pairs of papillae, one pair of which is bifid. The seventh pair, situated under the bifurcated papillae, this side of the anal opening, is not perceptible, while the posterior end is viewed here obliquely from the dorsal side. In this drawing as well as in the short description only one pair of bifurcated papillae is noted, which agrees with the description of the puparium given above. Otherwise this description is somewhat confusing, as only 10 of the 12 clearly visible tubercles are mentioned.

After having compared these various descriptions with what was seen by me on the puparia, I might conclude that on the posterior end of the larva there are probably 7 pairs of papillae, i.e. 3 pairs on the dorsal half, 3 pairs under the spiracles in an almost horizontal row, the middle pair of which is bifurcated with bifid or trifid tops, and the seventh pair more ventrally, this side of the anal opening. On the puparium only the bifid pair and the pair next to it is large and conspicuous, the 5 other pairs are usually hardly visible.

These papillae and the position of the slits are the most conspicuous characteristics of the puparia of this species, which resemble very much those of *Hylemyia pilipyga* Vill.

In northern latitudes the cabbage maggot may be very injurious to radish, cabbage, cauliflower, turnip, swede, and

mustardseed. They also feed on wild cruciferous plants i.e. *Barbarea praecox* R. Br., *Sisymbrium officinale* L., *S. altissimum* L., *Capsella bursa-pastoris* Mnch., *Raphanus raphanistrum* L., *Sinapis arvensis* L., *Brassica nigra* Koch. The white eggs are deposited in larger or smaller groups in the ground round the plants, or on the stems of the plants just above the surface. The first eggs are deposited in the end of April. The maggots hatch after 3 to 10 days and begin to eat, causing shallow grooves on the surface of the tender roots or stems. Soon however they burrow channels deeper into the plant. Rather than burrowing in woodlike parts the maggots burrow high into the stems, even into the leaf-stalks. On the cauliflower they have even been found in the inflorescence. After 3 or 4 weeks they are full-grown and pupate, mostly in the ground. After circa 8 days the flies of the second generation emerge. There may be 3 generations a year. The second and third generations usually attack wild cruciferous plants, the cultivated plants being then already too tough and hard. The attacked plants change in colour, their growth is retarded, the leaves wilt, finally the plants may die.

Chortophila (Egeria) cinerea Fall.

Hylemyia cinerea Fall.

Fig. 17.

Reared from *Tricholoma collossum*. Arnhem.

Puparia small: length 4,7 mm., largest diameter 1,8 mm. Shape normal, from the fourth abdominal segment onwards tapering towards the posterior end. Posterior end obliquely flattened, showing two stigma-bearing protuberances and a number of small papillae. Segmentation indistinct. On the anterior border of the second and third thoracic segments a few rows of extremely small spines. On the abdominal segments 8 belts of spines, alternating with finely wrinkled borders. The first 3 belts each preceded by a row of brown spots. These belts entirely located on the anterior border of the segments, the spines with their tops turned backward. The following belts showing also some rows of spines with

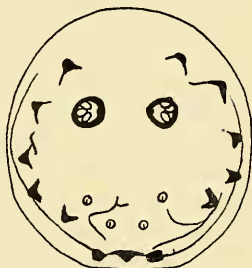


Fig. 17. *Chortophila cinerea* Fall.; posterior end ($\times 34$).

their tops turned forward, situated in front of the spots. Each of these belts containing from 4 to 5 rows of spines on the dorsal side, from 6 to 8 rows on the ventral side. The rows of spots dorsally and ventrally broken in the middle. Laterally here and there even some spots in between. The spines small, with broad bases, most of them singular, some bifid.

9 or 10 lobes counted on the larval prothoracic spiracles. The posterior spiracles on short protuberances, situated a short distance above the horizontal diameter of the posterior end. The distance between them one and a half times their horizontal diameter. Either spiracle with three short lobes, lying at acute angles and converging to the scar, which is situated in the middle of the inner edge. Round the spiracles 5 pairs of brown papillae. On the ventral half, near the median line 4 small, round spots, each showing a dark hair in its centre. At the ventral border a sixth pair of papillae and a single supra-anal papilla. The anal opening slit-like.

The most characteristic features of this puparium are the 6 pairs of papillae, the 2 pairs of spots and the single supra-anal papilla on the posterior end.

***Chortophila (Egeria) discreta* Mg.**

Fig. 18.

Puparia found in alluvial deposit of river Rhine near Herwen.

Small: length from 4,5 to 6 mm., largest diameter 1,8 mm. Rather dull colour, varying from yellowish brown to greyish brown. Posterior spiracles and ring round the posterior end reddish brown. Transverse section almost circular. Sides of the abdominal segments almost parallel. Puparium tapering towards the caudal end. Posterior end abruptly obliquely truncated, and encircled by a reddish-brown projecting ring. No papillae discernable by the naked eye, only two stigma-bearing protuberances. Segmentation indistinct, indicated by

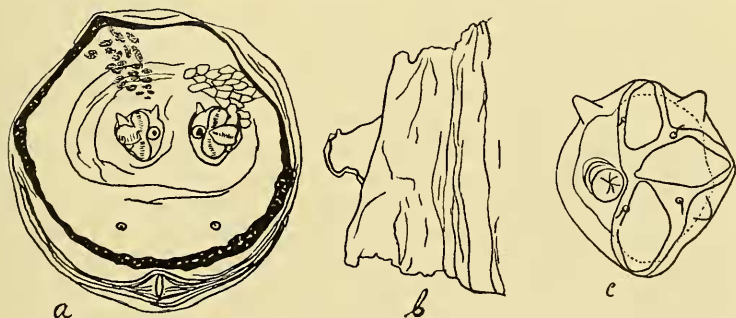


Fig. 18. *Chortophila discreta* Mg.; a posterior end ($\times 30$), b idem, lateral view ($\times 30$), c right posterior spiracle ($\times 115$).

more or less clear rows of spots. The first two thoracic segments "creased", the rest of the puparium transversely wrinkled, at the posterior end more heavily. The whole skin covered by a very fine reticulum of lines. The dark cephalopharyngeal skeleton reaching a short way into the first abdominal segment.

Larval prothoracic spiracles small. Number of lobes indistinct. Posterior spiracles on distinctly protuberant processes, which stand apart at their bases and converge slightly at their tops, touching the horizontal diameter of the posterior end. Bases of the protuberances coarsely granulated. The distance between the spiracles half as long as their horizontal diameter. Either spiracle with three wide slits. The middle slit almost horizontal, the two others nearly perpendicular. Between the slits 3 brown chitinized processes, not all three equally distinct. Near the slits small sensory organs visible: small brown circles on which a hair-like process. Scar round, clearly visible, raised above the surface of the stigmal plate. Only two very small papillae below the spiracles, visible from above as two small, round spots, with a dark sensory dot in their centre. The entire posterior end covered with inconspicuous brown spots or with a fine, brown reticulum. The slit-like anal opening in a circular, light coloured spot, surrounded by a dark coloured, broad ring.

This puparium differs considerably from that of other *Chortophila* species, here described, by its being abruptly truncated, by the projecting ring, and the presence of only 2 small papillae on the posterior end.

***Chortophila (Egeria) latipennis* Zett.**

Hylemyia latipennis Zett.

Fig. 19.

Larvae found in the leaf-stalks of *Athyrium filix femina* Rth. Hilversum.

Puparia medium-sized: length 7 mm., largest diameter nearly 2 mm. Colour shiny yellowish brown or light brown, only the thoracic segments dark brown. On the dorsal side of the thoracic segment a conspicuous, black spot, situated between the prothoracic spiracles. This spot at its lower edge somewhat broader, and showing rounded angles. Puparium normally shaped, tapering to its caudal end, somewhat constricted between the seventh and eighth abdominal segment. The posterior end almost perpendicularly flattened, without papillae. Segmentation indistinct. Encircling the puparium 7 belts of extremely small spines, as light coloured as the surrounding skin and only perceptible when magnified. In the first belt the spines joined, in the other belts the spines separate, but close together in transverse rows. The belts wider

on the ventral and lateral sides than on the dorsal side, the number of rows of each belt varying here from 5 to 10. The tops of the spines only clearly perceptible when magnified 400 times. Most spines with their tops towards the anterior end. This is the opposite of what is seen on most puparia. Only the spines of the last rows of some belts with their tops towards the posterior end. As they are so minute they probably do not take part in locomotion. The very fine wrinkles of the skin scarcely perceptible, even when magnified. The sturdy, black cephalopharyngeal skeleton reaches well into the first abdominal segment. It is clearly visible that its dorsal wingplates are forked.

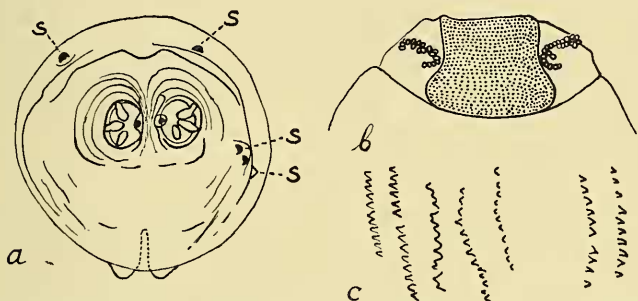


Fig. 19. *Chortophila latipennis* Zett.; a posterior end, particles of dirt, reminding of papillae ($\times 30$), b prothoracic segment, dorsal view ($\times 30$), c fragment of a dorsal belt of spines ($\times 154$).

The prothoracic spiracles slightly protruding on the dorsal side. The whitish, round or oval lobes, clearly visible. 17 lobes on the left, and 23 on the right spiracle of one puparium. Even the small slits perceptible. The large posterior spiracles on very short protuberances, touching the horizontal diameter of the posterior end. The distance between the spiracles less than the horizontal diameter of either stigmal plate. Either spiracle with 3 elongated slits, converging to the scar, which is situated in the inner edge of the stigmal plate. The middle slit horizontal or turned slightly upwards to the scar. The two other slits at acute angles. Neither papillae, nor spines on the posterior end. The anal opening long, slit-like. The brown or blackish brown irregular-shaped spots, which are scattered over the surface of the puparium are probably particles of dirt, clinging to the skin. Here and there they may remind us of papillae. So on two of the four specimens examined some papilla-like spots were noticed on the posterior end. It seems however hardly probable that these were really papillae, as the posterior end of the larva also is described by Prof. de Meijere (1907) as lacking protuberances.

The puparium of this species is characterized by the black spot on the prothoracic segment, by its lack of papillae on

the posterior end, and by the fact that the posterior spiracles are lying so very near to each other.

A detailed description of the morphology and habit of this species is given by Prof. de Meijere (1907). After comparing the description of the larva, given by this author, with that of the puparium given here, it appears that all details, visible on the larva, are still visible on the puparium. Only the colour has changed from yellowish white or straw-yellow on the larva into yellowish brown or light brown on the puparium. The larva is able to retract the hardly protruding posterior spiracles into a transverse groove.

The following may be cited about the habit: The larva mines in the leaf-stalks of *Athyrium filix femina* Rth. The mine runs downward through the leaf-stalk and ends in the leaf-sheath, which is also partly mined. Then the larva turns round and leaves the mine by an opening, made high-up in the concave surface of the sheath. The excrements, partly filling the mine, are a light brown, crumbly powder. The attacked leaf-stalks are black coloured, the corresponding leaf-blade is under-developed, small and withered. The mines as well as the disfigurement of the leaf resemble closely that, caused by the larva of *Heptamelus ochroleucus* Staph. (*Tenthredinid*), which lives in the same fern. The difference is, that the larva of *Heptamelus ochroleucus* on several places eats the tissue away to close under the epidermis, so that the mine shows several round, thin-walled spots on the concave side of the leaf-stalk. These spots are never found on the mines of *Chortophila latipennis*. Full-grown larvae were found in the end of July and in the first half of August. They probably leave the mine to pupate. The puparia hibernate. The imagines appear at the end of May or at the beginning of June.

Chortophila (*Egeria*) *lineata* Stein.

Fig. 20.

Larvae found in the capitula of *Sonchus* spec., Loosduinen.

Only one puparium present. Small, the ventral and dorsal pieces, lying before the circular line of dehiscence, broken off. So the total length of the puparium hard to determine. The length of the remaining part 4.5 mm. Largest diameter circa 1.7 mm. Colour yellowish brown. The sides of the first abdominal segments almost parallel, the last segments narrowing towards the posterior end. Posterior end flattened, showing two stigma-bearing protuberances. Segmentation indistinct. Encircling the abdominal segments some rows of inconspicuous spots. Some distance below those spots a few broken rows of extremely small spines, which are most numerous on the first abdominal segments and seem to be lacking on the last ones. In the middle of the lateral parts

spines only found on the first two abdominal segments. Most spines joined in rows, and with their tops turned towards the posterior end. The skin of the abdominal segments transversely wrinkled, that of the last segments very irregularly, so that there the skin looks "creased".

The posterior spiracles on cylindrical, diverging protuberances, situated in the dorsal half of the posterior end. The distance between the spiracles somewhat more than once

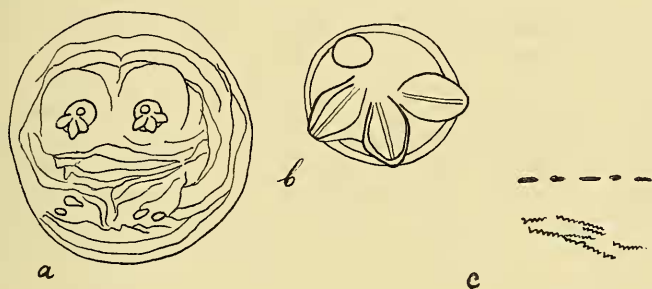


Fig. 20. *Chortophila lineata* Stein; a posterior end ($\times 34$), b right posterior spiracle ($\times 172$), c part of a belt of spines ($\times 230$).

their own horizontal diameter. The position of the 3 lobes and the scar very striking: the middle lobe almost perpendicular, the two others lying at acute angles to the middle lobe. The scar situated above the lobes, high up at the inner edge of the stigmal plate. No papillae on the posterior end. Under the spiracles a network of brown chitin-wrinkles, in which two spots at either side. The anal opening situated on the ventral side, not visible when the posterior end is viewed as in the figure given here.

The position of the lobes and scar on the posterior spiracles, and the absence of papillae are the most remarkable characteristics of the puparium of this species.

Sensory papillae, 5 pairs of which are described on the posterior end of the larva by Mrs. de Vos-de Wilde (1935) have not been noticed on the puparium. Neither thick chitin teeth, nor small spines were present on the posterior end of the single puparium examined. The examination of more puparia is desirable.

Chortophila (Egeria) pullula Zett.

Hylemyia pullula Zett.

Fig. 21.

Puparia found in alluvial deposit of river Rhine near Herwen.

Small: length of the two puparia examined 4 and 5 mm.,

their largest diameter respectively 1,5 and 1,8 mm. Colour dark brown, the papillae and spiracles on the posterior end still darker coloured. Shape normal, narrowing suddenly towards the anterior end, and tapering towards the small posterior end. Halfway the second abdominal segment a slight constriction. The posterior end obliquely flattened. Encircling the puparium 8 belts of spines at the junction of the abdominal segments. From the third abdominal segment onwards also spines on the posterior border of the segments, forming with those of the following segment one belt. The belts wider on the lateral and ventral sides, narrower on the dorsal side. Along the anterior borders of the abdominal segments rows of spots. On the dorsal and lateral sides these rows of spots branched off into two rows, which meet again somewhat farther on. These spines situated on the posterior border of the segments with their tops turned forward, those, situated under the rows of spots, with their tops turned backward. The spines dark coloured at their bases, light coloured at their tops, in the first abdominal segments arranged in short rows of 5 spines together, on the rest of the puparium irregularly spread. Transverse wrinkles alternating with the belts of spines. The cephalopharyngeal skeleton reaching a short way into the first abdominal segment.



Fig. 21. *Chortophila pullula* Zett.; a posterior end ($\times 46$), b fragment of belt of spines with spots ($\times 115$).

The number of lobes of the prothoracic spiracles hard to count. The posterior spiracles on short, diverging protuberances, situated in the dorsal half of the posterior end, a short distance above its horizontal diameter. The distance between them circa one and a half times their own horizontal diameter. Either spiracle with 3 slits, converging to the scar, which is situated at the inner edge of the stigmal plate. 8 pairs of dark coloured papillae on the posterior end, two pairs of which are smaller than the others and situated close together under the spiracles. On some puparia, they even seem to form one pair of bifid papillae. The posterior end

covered with very small, brown spines. Under the slit-like anal opening a brown, transverse-elongated spot.

The puparium of this species is characterized by the 8 pairs of dark coloured papillae, by the position of the spiracles, and the large number of small spines on the posterior end.

The larva may be injurious to *Iris* and *Gladiolus*, by eating the flowers, the leaves, and the stems.

Chortophila (Egeria) seneciella Meade.

Fig. 22.

Larvae found in capitula of *Senecio jacobaea* L. Bussum.

Puparium small : circa 5 mm. long, the largest diameter circa 1,7 mm. Of the three specimens, present in the collection, one light brown, one grey-brown, as if clay were deposited on it, and one dark brown. Shape normal, sides of the abdominal segments parallel as far as the sixth segment, from here on tapering to the caudal end. The posterior end obliquely flattened, showing two stigma-bearing protuberances. Segmentation barely perceptible. The whole surface rather heavily and irregularly transversely wrinkled. Only the first two thoracic segments "creased". At the anterior end of the second and third thoracic segments, and of the first abdominal segment a number of spines, arranged in a few rows. The surface of the other abdominal segments completely beset with more or less pointed spines on the dorsal, the ventral, and on the lateral sides. Belts, where the spines are very conspicuous and arranged in broken rows, alternating with belts where they are shorter, less noticeable and often arranged quite irregularly. On the light coloured specimens examined, the spines very indistinct and short. Spines on the posterior end only clearly perceptible outside the ring of papillae. All spines with their tops towards the posterior end. Laterally at either side two rows of slight hollowings-out. In these shallow grooves some dark spots. The cephalopharyngeal skeleton reaching well into the first abdominal segment.

Mrs. B. de Vos-de Wilde (1935) gives a detailed description of the larva of this species. According to this author each segment is provided with one pair of papillae on the ventral side. She mentions also 2 rows of such papillae on the dorsal side, sometimes in groups of 2 or 3 together, and several papillae on the swellings of the lateral sides. On the lateral sides their number varies from 2 to 5. On the puparium these papillae are not perceptible any longer. Bare spots, round or oval, along which the spines seem to run, often indicate very distinctly the places where, on the larva, the papillae have been.

14 lobes were counted on the prothoracic spiracles (Mrs. de Vos-de Wilde counts 12 or 13 lobes on the larva, and states that this number may differ on the right and the left side of one larva.) On the larva the lobes are long and nar-

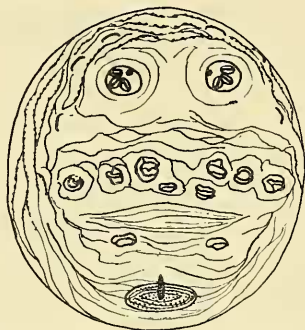


Fig. 22. *Chortophila seneciella* Meade; posterior end ($\times 30$).

row, on the puparium they are shortened to small, semicircular knobs. The posterior spiracles, on the tops of distinctly raised cylindrical protuberances, which are wide apart at their bases and somewhat diverging to their tops, situated high-up in the dorsal part of the posterior end. The distance between the spiracles not quite twice their own horizontal diameter. 3 wide slits, converging upwards to the scar. Scar distinct, at the upper edge of the stigmal plate. The 3 slits lying at acute angles to each other. 8 pairs of papillae, only slightly raised, often indistinct, and seemingly tangled wrinkles. Division of papillae as follows: 3 pairs located in half a circle round the spiracles, and 3 pairs in an almost horizontal row below the spiracles, a seventh pair a little lower near the median line, and the eighth pair at some distance this side of the anal opening. In this respect figure 22 differs from that of the larva, drawn by Mrs. de Vos-de Wilde, where the eighth pair of papillae is situated lower down, to the left and to the right of the anal opening. The slitlike anal opening surrounded by a transverse, oval, brown coloured spot.

The large number of spines on the abdominal segments, the position of the 8 pairs of very short papillae on the posterior end, and the situation of the scar on the stigmal plate are the most conspicuous characteristics of the puparium of this species.

Séguy records about the habit: The larva of *C. seneciella* lives among the disk-flowers of *Senecio jacobaea* L. The imagines hatch towards the end of June, at the time when the capitula of *Senecio jacobaea* are beginning to open. The female only lays one egg on each capitulum. The larva hatches

quickly. It is found with its head turned towards the involucre, which it eats partly, its anal end turned upwards. The capitula carrying these larvae are easily recognized on account of their spumous appearance. The spume covers and protects the posterior end of the larva. This spumous cone is analogous to the spume secreted by the larva of *Aphrophora* (Giard). The larva of *C. seneciella* has been found in England on *Senecio aquaticus* Hudz., (Inchbald, Meade).

Chortophila (Egeria) signata Brischke, de Meijere.

Fig. 23.

Puparia found in fronds of *Athyrium filix femina* Rth. Hilversum.

Small: length from 4 to 5 mm., largest diameter 1.5 mm. Colour varying from light to dark brown, the papillae on the posterior end darker than the rest of the puparium. Shape normal. The anterior end dorsoventrally flattened, the posterior end obliquely flattened. Segmentation distinct. The three thoracic segments dorsally devoid of spines. Ventrally on the second and third of these segments 3 or 4 rows of spines at the anterior end. The abdominal segments sometimes completely beset with large, pointed spines. On some specimens examined ventrally in the middle of the segments, and where two segments meet, narrow spineless belts. Prof. de Meijere (1907) records in his description of this species that the spines on the ventral side of the larva are very few in number. So there seem to be considerable individual differences in this respect. On the anterior part of each segment most spines with their tops towards the caudal end, on the posterior part towards the anterior end. Most spines situated wide apart. The posterior end also beset with spines, except a small space below the posterior spiracles, and a space at

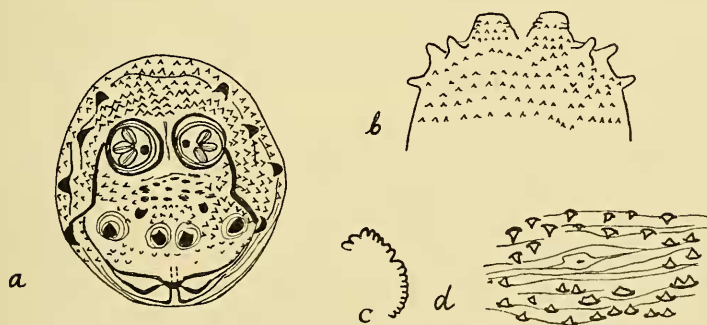


Fig. 23. *Chortophila signata* Brischke, de Meijere; a posterior end ($\times 34$), b idem, viewed from the dorsal side ($\times 34$), c larval prothoracic spiracle ($\times 230$), d brown spot, situated between the spines in lateral hollowing out ($\times 172$).

this side of the anal opening. In the slight hollowings-out, arranged in 3 longitudinal rows on either side, spots with a dark dot in their centre. These spots surrounded by spineless spaces, just there where the spines with their tops towards the posterior end meet those with their tops towards the anterior end. The skin finely transversely wrinkled, on the thoracic segments rather more irregularly. The cephalopharyngeal skeleton reaching some way into the first abdominal segment.

On the prothoracic spiracles only 18 lobes perceptible, divided into two groups. (Prof. de Meijere (1907) observed on the larva more than 20 very short-stemmed lobes.) The posterior spiracles on rather short, truncated-conical protuberances. These protuberances close together, though not touching at their bases and slightly diverging at their tops. Either protuberance beset with spines, and encircled at its base by a brown ring. The spiracles situated close together, a short distance above the dorsal half of the posterior end, the distance between them less than the horizontal diameter of the stigmal plates. On either spiracle 3 elongated slits, converging to the scar, which is situated at the inner edge of the stigmal plate. The middle slit nearly horizontal, the two others situated at acute angles. The dark coloured papillae, 16, perhaps 17 or even 19 in number, placed as follows: 3 pairs on the dorsal half, 4 pairs under the spiracles, one pair of which is situated close to the median line, and another pair at the bottom edge of the posterior end. Between the papillae of this last mentioned pair a dark thickening, which reminds one of a papilla. It is hard to decide whether this is actually a papilla or only a chitin-thickening, and I mention this single supra-anal papilla with all the more restriction, as Prof. de Meijere (1907) in his detailed description of the morphology and habit of this species does not record it. This investigator counted 9 pairs of papillae on the posterior end of the larva, i.e., the 8 pairs which are still visible on the puparium, and a ninth pair, situated under the anal opening. Only on one of the three puparia examined, an indication of this last pair was visible.

The last sentence of the description of the puparium, given by Müller *), and quoted by Prof. de Meijere loc. cit. is repeated here. It runs: "Segments of the puparium, and a row of lateral stigmata on either side, visible to the naked eye". These "lateral stigmata" are not spiracles but are probably the small sensory pits, three rows of which are described here. The description of the papillae by Müller is very incomplete.

The puparium of this species is characterized by the large number of spines and the position of the spiracles and pa-

*) Müller, Entom. Monthl. Mag. VIII 1871/72 p. 181.

pillae on the posterior end, though the number of the latter, being 16, 17 or 19, could not be fixed with certainty.

About the habit of this species the following may be cited from the description, given by Prof. de Meijere (1907): The larva of *C. signata* causes the leaf-top of *Athyrium filix femina* to curl up. A number of the upper pinnae is curved. They form a cavity, which is filled with black, granular excrements. The maggot, lying in this space, seems to injure the middle-rib of the leaf on the upperside, and so to cause the curling-up. The attacked pinnae are all under-developed. Those immediately below the curled ones are quite normally developed.

The beginning of a similar injury on *Polystichum spinulosum* D.C. has been found only once by Prof. de Meijere. Lagerheim mentions the same injury on *Athyrium alpestre* (Hoppe) Nyl. Whether the curling-up of the fronds of *Nephrodium* (*Aspidium*) *filix mas* Rth., *N. thelipteryx* Rth., *N. cristatum* Rth., and *Pteris aquilina* L., recorded by Houard, is also caused by *C. signata*, remains doubtful.

The white, elongated egg, circa 1 mm. long, is laid outside on the tops of the young fronds of *Athyrium filix femina* Rth. The rolling-up of the fern-leaves begins already in the last days of May. Though the fronds are then not yet quite developed, the attacked tops are already easily recognizable. The deformations, caused by the larvae, are most often noticed in June. At the end of June full-grown larvae are found. The pupation may take place in the beginning of July.

***Chortophila* (*Crinura*) *antiqua* Mg.**

Hylemyia antiqua Mg.

Fig. 24.

Larvae found in the bulbs of onions. Wageningen.

The one puparium available medium-sized: length 6.2 mm., largest diameter circa 1.8 mm. Colour light brown, the papillae on the posterior end darker coloured. Shape normal. Sides from the sixth abdominal segments onwards tapering towards the caudal end. Posterior end obliquely flattened, showing two short stigma-bearing protuberances and a number of papillae. Segmentation marked by distinct rows of brown spots, which are broken in the middle of the ventral side. Laterally these rows of spots branched off into two rows, which meet again somewhat farther on. In the middle of the dorsal side some of the rows double. On the ventral side belts of spines, arranged in irregular rows, the number of which varies from 2 to 4 on the second and third thoracic segment, on the abdominal segments from 5 to 10. These belts narrowing towards the sides and broken in the middle of the sides, continuing on the dorsal side only on the first four abdominal-segments. On the seventh abdominal segment

the spines very irregularly spread over the surface. The spines in front of the slit-like anal opening somewhat larger than the others. The whole skin finely transversely wrinkled. The cephalopharyngeal skeleton short, reaching a short way into the third thoracic segment.

The dorsal thoracic piece with the prothoracic spiracles lacking on the one puparium available. The posterior spiracles on short protuberances, situated in the dorsal half of the posterior end. The distance between them circa as large as their own horizontal diameter. Either spiracle with 3 broad lobes, converging to the scar. Scar distinct, in the upper inner edge of the stigmal plate. 3 pairs of papillae on the dorsal half of the posterior end. Under the spiracles one pair of very large papillae, which show alternately light- and dark-coloured rings. Next to it another ringed pair of papillae. Near the median line, under the large papillae a pair of very small ones. A seventh pair situated more laterally, the eighth pair lower down, at the right and left side of a single supra-anal papilla. Round the slit-like anal opening a transverse-elongated, brown coloured border.

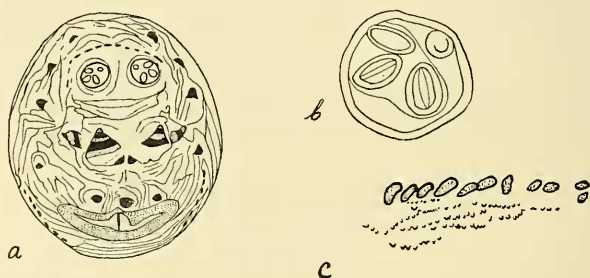


Fig. 24. *Chortophila antiqua* Mg. : a posterior end ($\times 23$), b left posterior spiracle ($\times 115$), c fragment of belt of spines and row of spots ($\times 230$).

The puparium of *C. antiqua* Mg. is characterized by the shape and position of the 17 papillae on the posterior end.

K. M. Smith (1922) counted the same number of papillae on the posterior end of the larva. The description of the larva and puparium by Bouché (1843), who calls this species *Anthomyia ceparum* Mg., is very incomplete.

The larvae of *C. antiqua* are destructive to onions. According to K. M. Smith they occasionally attack shallots and leek, and have been recorded as feeding on tulip bulbs and lettuce. There are 3 generations in a season. The white, elongated eggs are deposited on the lower parts of the leaves and stalks of onions, occasionally in the ground close to the stalks, or on the bulb itself. They are laid in groups of 6 to 30 together. The larvae hatch after 2 to 5 days. The larvae of the first

generation begin to eat in the leaf-stalks. Only after the leaves have wilted and the plant has died off they start burrowing into the bulbs. The larvae of the second and third generation may penetrate immediately into the bulb. The worst damage occurs in the spring, when the onions are still small and are devoured on a large scale, the larvae migrating from onion to onion, leaving nothing but the green portion above the ground. On older plants indications of attack are the yellowing and wilting of the tops, which finally lie flat on the ground, the bulb in bad cases being reduced to a rotting, semi-liquid mass. Any number of maggots from 3 or 4 to 25 or 30 may be found in one onion bulb. In an onion their development takes from 15 to 25 days. They pupate in the upper layers of the earth near the plants. In the summer the pupal stage lasts from 8 to 14 days, in the winter from 190 to 210 days. Usually the puparia of the third generation hibernate.

Chortophila (Crinura) florilega Zett.

Chortophila cilicrura Rond.

Fig. 25.

Puparium found in alluvial deposit of river Rhine near Herwen.

Small: length 4.5 mm., largest diameter about 1.3 mm. Colour varying from yellowish brown to bright dark brown. Shape normal, the ventral side flat, the dorsal side convex. Sides of the abdominal segments almost parallel. The posterior end obliquely flattened, showing two short, stigma-bearing protuberances, and a number of papillae. Segmen-

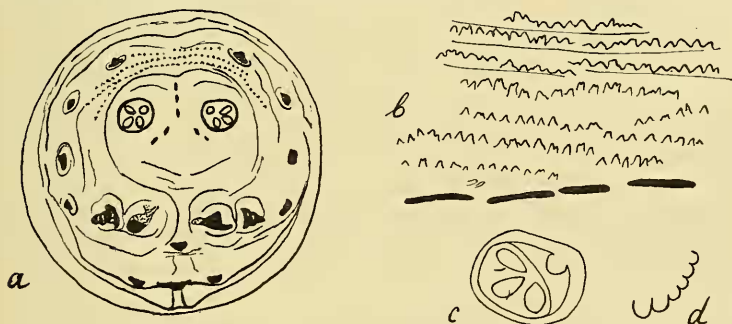


Fig. 25. *Chortophila florilega* Zett.; a posterior end ($\times 36$), b belt of spines, ventral part ($\times 154$), c left posterior spiracle ($\times 230$), d prothoracic spiracle ($\times 230$).

tation of some specimens more distinct than of others, mostly marked by a row of light or dark coloured spots. Behind these spots on the abdominal segments some short, sometimes bifid spines, arranged in irregular broken rows, from

3 to 5 rows on the dorsal side, from 6 to 10 rows on the ventral side of each segment. The spines with their tops towards the posterior end. They may be lacking on the seventh and eighth segment. The first thoracic segment "creased", the second with thick brown wrinkles, the rest of the puparium finely transversely wrinkled.

Larval prothoracic spiracles with 6 or 7 lobes. Posterior spiracles on two short, cylindrical, somewhat diverging protuberances, located in the dorsal half of the posterior end, high above the horizontal diameter. The distance between the spiracles not quite twice their own horizontal diameter. Either spiracle with 3 wide slits. The middle slit pointing obliquely upward to the scar, the other two lying at angles, somewhat smaller than 90 degrees. Hairlike sensory organs visible between the slits. Scar round, clearly visible, slightly raised, situated at the upper inner edge of the stigmal plate. 4 pairs of small papillae, and 2 pairs of larger ones round the spiracles. A little lower in the median line one solitary papilla. Right above the slitlike anal opening another single papilla between a seventh pair of papillae.

The two solitary supra-anal papillae, situated one above the other, are found only in this *Chortophila* species, and are the most striking characteristic.

The eggs are laid on the stems, lowest leaves and on the roots of various plants, or in the ground. One female may produce from 30 to 90 eggs. The larval stage lasts from 8 to 12 days, the pupal stage from 8 to 14 days or longer. They pass the winter as a puparium or as an imago. Pupation occurs in the upper layers of the ground. There may be 3 generations a year, respectively in May, in June or July, and in September. Sorauer mentions that they are found a.o. in beans, peas, lettuce, cereals, cabbage, radish, seed-potatoes, leek, red clover, onions, and mustard-seed. In Silesia the maggots have been the cause of an utter destruction of the seedlings of lupin and rye by eating the seeds. Séguv mentions parsley and *Asparagus* as feeding plants. They are also found in insects and in excrements. Künckel d'Herculaïs states, that they may destroy the eggs of the migratory locust. The English name for this maggot is : seed-corn maggot.

***Chortophila* (*Thrixina*) *fugax* Mg.**

Hylemyia fugax Mg.

Fig. 26.

Larvae found in the Netherlands, special locality not recorded.

Puparia small : length from 4,5 to 5 mm., largest diameter 1,5 mm. Colour greyish brown. Shape normal, tapering towards the last segment, which has parallel sides. Posterior

end nearly perpendicularly flattened, showing two stigma-bearing protuberances and a number of pointed, large papillae. Segmentation distinct, moreover indicated by rows of elongated, dark spots. Nearly the whole puparium, from the third thoracic segment onwards, covered with short, brown spines. No conspicuous spines on the posterior end, except some on the papillae. Spines on the second thoracic segment very small or lacking. The first thoracic segment irregularly wrinkled, the rest of the puparium finely transversely wrinkled. These wrinkles hardly perceptible between the spines. The cephalopharyngeal skeleton reaching a little into the first abdominal segment.



Fig. 26. *Chortophila fugax* Mg. ; posterior end ($\times 46$).

Larval prothoracic spiracles not clearly perceptible. Posterior spiracles light coloured, located on somewhat diverging protuberances, which are wide apart at their bases, and situated in the dorsal part of the posterior end. The distance between the spiracles twice their horizontal diameter. Either spiracle with 3 slits lying at acute angles, converging to the scar, which is situated at the inner edge of the stigmal plate. 6 pairs of large, pointed, brown papillae round the posterior spiracles. On some of these papillae small spines perceptible. Near the ventral edge of the posterior end within the circle of papillae some brown, slightly raised spots, which are not present in the same number and position on the 2 specimens examined. The anal opening slit-like.

The many spines, scattered over the skin, except on the first segment and the posterior end, the 6 pairs of large, pointed, dark coloured papillae, the small spots near the bottom edge and the wide distance between the light coloured posterior spiracles are the most characteristic features of the puparia of this species.

Frost (1923) mentions only 5 pairs of tubercles on the posterior end of the larve and apparently found minute spines only on the borders of the segments. It is hard to find an explanation to account for these differences.

About the habit of this species this author records : *Hylemyia fugax* Mg. is a fairly common miner on the leaves of spinach and beet and on the leaves of several weeds. Frost states to have reared the species from *Chenopodium album* L. and *Amaranthus retroflexus* L. The former was found to be the favourite food plant of the larva. The incubation period of the eggs appeared to be from 11 to 14 days. Eggs were found in abundance from June 5 to June 22, but after the latter date it was difficult to find them. By the middle of the summer no larvae could be found. From these facts it was supposed that there is but one generation a season. The eggs are laid singly. The mines are at first linear and short, from three-fourths of an inch to an inch in length. These short mines are frequently curved and script-like. Later on they broaden out into a blotch mine, and cannot be distinguished from those, produced by the larvae of *Pegomyia hyoscyami* Panz. The larvae abandon the leaves to transform, and the adults issue about 16 days after the formation of the puparia.

Chortophila (Thrixina) octoguttata Zett.

Fig. 27.

Puparium found in alluvial deposit of river Rhine near Herwen.

Small : length 3.75 mm., largest diameter 1.2 mm. The only puparium, present in the collection, light brown, the anterior and posterior spiracles, the papillae on the posterior end, and the elongated spot below the anal opening darker coloured. Shape normal, slightly tapering towards the caudal end. Posterior end obliquely flattened, showing two stigma-bearing swellings, and a number of papillae. Segmentation

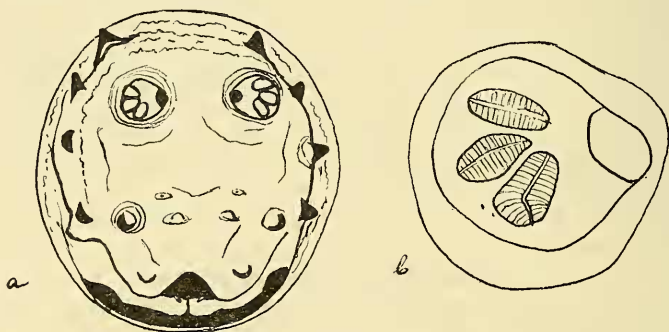


Fig. 27. *Chortophila octoguttata* Zett. ; a posterior end ($\times 46$),
b left posterior spiracle ($\times 230$).

indistinct. Encircling the puparium 7 belts of large, pointed spines, the anterior belt situated at the anterior end of the first abdominal segment. On the ventral side the belts some-

what wider than on the dorsal side. Most spines large, brown, with their tops towards the posterior end. Especially in the first two belts every 2 of 3 spines close together, on the other segments the spines for the larger part one by one, and irregularly spread over the surface. On the dorsal side from 3 to 5 rows, on the ventral side from 5 to 7 rows of spines in each belt. Laterally, in front of the second belt some single pointed, colourless spines, with their tops towards the anterior end. On some distance in front of each of the following belts from 1 to 4 rows of such spines. Between the spined areas the skin very finely wrinkled. The black cephalopharyngeal skeleton reaching into the first abdominal segment.

The larval prothoracic spiracles brown, with 12 distinct, oval lobes. The posterior spiracles on short protuberances, situated in the dorsal part of the posterior end. The distance between them circa one and a half times their horizontal diameter. The upper and middle slit on either spiracle straight, the lowest slit curved inwards at the bottom. The middle slit pointing obliquely upward to the scar, the other two lying at acute angles. The scar round, at the inner edge of the stigmal plate. 8 pairs of sensory papillae on the posterior end: 10 large papillae round the spiracles, and 4 small papillae, only slightly raised, near the median line. The eighth pair of papillae situated on the lower part of the posterior end. The anal opening slit-like. Lower down a very narrow, transverse-elongated, brown spot.

The 6 pairs of distinct papillae, the 2 pairs of small papillae, and the shape of the posterior spiracles are the most conspicuous characteristics of the puparium of this species.

***Chortophila (Nudaria) dissecta* Mg.**

Fig. 28.

Puparia found in alluvial deposit of river Rhine near Herwen.

Small: length 3,5 to 4,5 mm., largest diameter about 1,3 mm. Colour varying from yellowish brown to shiny deep brown. The papillae and spiracles on the posterior end darker coloured than the rest of the puparium. Shape normal, sometimes slightly dorsoventrally flattened. Sides of the first abdominal segments parallel. Breadth diminishing from the sixth to the last abdominal segment, which has parallel sides. The posterior end almost perpendicularly flattened, showing two stigma-bearing protuberances and a number of papillae. Segmentation distinct, marked by distinct rows of brown spots. Behind these spots on the dorsal side of the first five abdominal segments, from 1 to 4 broken rows of extremely small spines, laterally the rows of spines only continuous on the first three abdominal segments. On the ventral side wi-

der belts, beset with somewhat larger spines or lumps, these belts being widest near the median-line, the number of rows varying there from 6 to 11. The whole puparium finely transversely striated, except the last segment, which is entirely covered with spines. Only the space round the posterior spiracles without spines. On each segment on either side 1 or 2 slight hollowings-out visible, when magnified about 10 times. Microscopically, in these places short longitudinal rows of brown spots, situated between the transverse wrinkles. The dark cephalopharyngeal skeleton reaching halfway down the first abdominal segment.

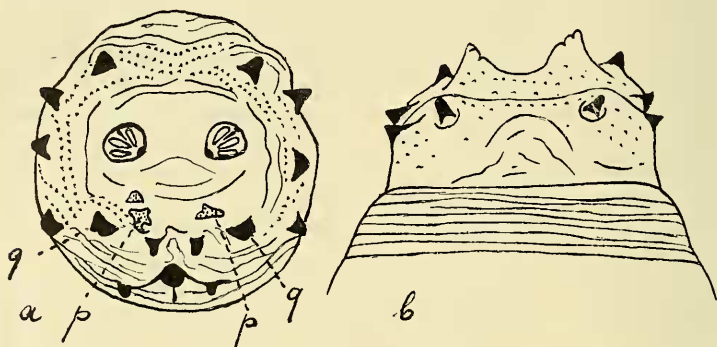


Fig. 28. *Chortophila dissecta* Mg.; a posterior end, b idem, dorsal view ($\times 46$).

On the larval prothoracic spiracles probably 12 or 13 lobes. The posterior spiracles situated on distinct, conical protuberances, namely on the sides turned to the median line. The cones which stand apart at their bases, situated in the dorsal half, almost reaching the horizontal diameter of the posterior end. Their sides beset with spines. The distance between the spiracles not quite twice their own horizontal diameter. Either spiracle with 3 long, converging slits, lying at acute angles. Between the upper and middle slit a dark, elongated spot, sharpening downwards to a point. The scar more or less clear, situated at the lower edge of the stigmal plate, near the median line. 3 pairs of papillae on the dorsal half, and 4 pairs under the spiracles. The papillae, marked q in the figure may be bifid, the papillae marked p may be small and indistinct. Moreover, one papilla on either side of the slit like anal opening, and one single supra-anal papilla on the median line.

Particularly the single supra-anal papilla, the 7 pairs of papillae, the conical stigma-bearing protuberances, and the location of the scar and the lobes on the stigmal plates are distinguishing characteristics of the puparium of this species.

***Chortophila (Nudaria) intersecta* Mg.**

Fig. 29.

Puparia found in alluvial deposit of river Rhine near Herwen.

Small: length varying from 4 to 4.5 mm., largest diameter from 1.2 to 1.7 mm. Colour of all specimens examined yellowish brown. The papillae on the posterior end somewhat darker coloured than the rest of the puparium. The larval prothoracic spiracles black. Shape normal, sides of the first abdominal segments almost parallel, from the sixth segment onwards slightly converging to the caudal end. The ventral side flattened, the dorsal side convex. Posterior end obliquely flattened, bearing two cylindrical protuberances on which the spiracles, and 7 pairs of papillae. Segmentation distinct. Encircling the abdominal segments at the anterior ends, belts of extremely fine spines, each belt consisting of 3 to 6 rows of spines. The spines close together. Laterally and ventrally the belts of spines sometimes broken. In front of each belt a row of oval spots. The whole puparium finely transversely wrinkled. Laterally at either side two longitudinal rows of slight hollowings-out. The dark cephalopharyngeal skeleton reaching well into the first abdominal segment.

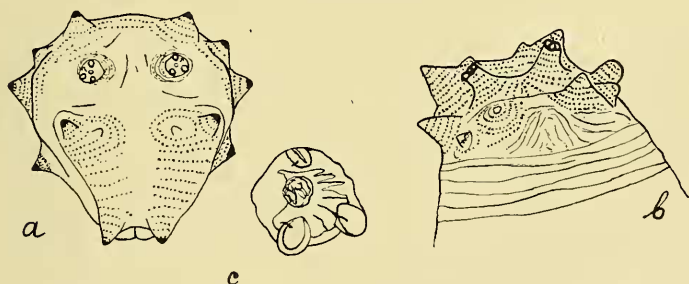


Fig. 29. *Chortophila intersecta* Mg.; a posterior end ($\times 30$), b idem, dorsal view ($\times 30$), c right posterior spiracle ($\times 154$).

The larval prothoracic spiracles bearing only a few lobes, probably 6 or 7. The posterior spiracles on cylindrical protuberances, situated high-up in the dorsal half of the posterior end. The protuberances not touching at their bases, diverging at their tops. The spiracles small, the distance between them circa three times their own horizontal diameter. Either spiracle with 3 short, almost circular lobes, wide apart on the sides of the stigmal plate. On each lobe a thick hair-like sensory organ. The scar situated a little off the centre. 3 pairs of papillae on the dorsal half of the posterior end. On the ventral half 4 pairs of papillae, i.e., one large lateral

pair, another large, lateral pair on the projecting ventral lip and a smaller pair nearer the median line, the seventh pair at the bottom, on this side of the anal opening. The protuberances as well as the papillae, and a large part of the surface between them, beset with extremely small spines, which even microscopically are hardly visible.

The small posterior spiracles, the position of the short, broad lobes, the distinctly projecting ventral part, and the 7 pairs of papillae are the most conspicuous characteristics of the puparium of this species.

Bouché (1834) describes the puparium of this species as being elliptic, egg-shaped, reddish brown, with black, far projecting prothoracic spiracles, and blackish brown stigma-bearing protuberances on the posterior end. The small, yellowish brown spiracles are described as turned far outward. The number of 12 fleshy processes round the posterior end of the larva and the two small protuberances above the anus correspond also to the figure given here. According to this author the larva is coprophagous. The pupal stage lasts from 2 to 3 weeks. More than one generation develops each summer.

***Pycnoglossa cinerosa* Zett.**

Hylemyia cinerosa Zett.

Fig. 30.

Larvae found in leaf-mines of *Pteris aquilina* L., Hilversum.

Puparium small: length 3,2 mm., largest diameter 1 mm. Colour shiny brown. Shape normal: abruptly narrowing towards the anterior end, tapering from the fifth abdominal segment onwards to the posterior end, the transverse section rather small here. The posterior end flattened, with two stigma-bearing protuberances. Segmentation distinct. Microscopically the junction of the segments indicated by transverse rows of oval spots. Behind these spots some rows of extremely small spines. On the last few abdominal segments also in front of these spots some rows of very small spines.

The borders between the 3 thoracic segments conspicuous by 2 thick chitin wrinkles. On the first thoracic segment thick, brown chitin wrinkles, running longitudinally; on the second and third thoracic segment thick wrinkles, running transversely. The skin of the abdominal segments more thinly transversely wrinkled. With a pocket-lens two longitudinal rows of slight hollowings-out visible. On either side of each segment two of these hollowings out, i.e., one laterally, the other somewhat more towards the dorsal side. On the bottom of these shallow hollowings-out one or more dark, round spots.

The prothoracic spiracles blackish brown. The number of

lobes a few more than 10. (Prof. de Meijere (1907) counts 13 lobes on the larva). The posterior spiracles on widely diverging protuberances, high up in the dorsal half of the posterior end. The distance between the spiracles not quite half as long as their own horizontal diameter. On the single specimen available on either spiracle the thin-walled part of only 2 lobes perceptible. The presence of the third lobe on this spe-

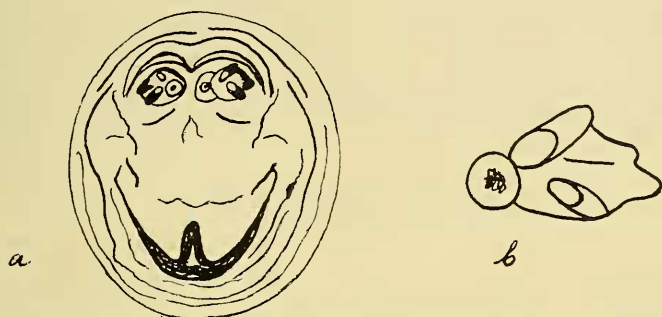


Fig. 30. *Pycnoglossa cinerosa* Zett. ; a posterior end ($\times 46$),
b right posterior spiracle ($\times 230$).

cimen only indicated by its thick, brown chitinized distal end. For the position of the lobes see fig. 30 b. Peritrema indistinct. The scar large, distinct. No papillae or conspicuous spots on the posterior end. The chitin round the slit-like anal opening deep-brown coloured just as the wrinkles on the dorsal and lateral side of the posterior end.

The position of the lobes of the posterior spiracles, the absence of papillae or spots on the posterior end, perhaps also the indistinct peritrema are the most conspicuous characteristics of the puparium of this species.

Prof. de Meijere (1907) observes 3 sessile lobes on the posterior spiracles of the larva of *H. cinerosa*. The middle one of these lobes is described as being the longest and extending farther than the other two. This agrees with the figure given here, though the middle lobe is not clearly visible on the puparium. The tuft of hair and the 4 small circular rings, sketched on the stigmal plate of the larva (Pl. LIV fig 30) are not visible any longer on the puparium. This investigator mentions also that the 8 very short protuberances, occurring on the posterior end of the larva, are lacking on the puparium.

From his description of the habit of this species the following may be cited : The larva mines in the ends of the leaves of *Pteris aquilina*. The mined part of the leaf remains flat. The mine extends usually over circa 5 leaflets. It is from 3 to 4 cm. long. The mines are mostly found in the tops of the fronds, sometimes however in one of the largest pinnae of

the lower leaves. The excrements lie in the leaflets in one broad, black row, broken here and there. The white, elongated egg is laid on the outside of the leaf, mostly on the midrib and in the same direction to this. The larva first eats its way up on one side of the midrib. Arrived at the top it turns round and starts to eat on the other side of the midrib, down to the place where the eggshell is still lying. From there the larva seems to attack in turn a leaflet on the right and one on the left side of the midrib. When going to pupate the larva leaves the mine and goes into the earth. Empty mines were found in the end of June and in July. In the very warm summer of 1904 larvae were still found in August, which larvae may have been those of a second generation.

Phorbia genitalis Schnabl

Fig. 31.

Puparia found in alluvial deposit of river Rhine near Herwen.

Small: length 4,5 mm., largest diameter 1,5 mm. Colour yellowish brown, darkened at the anterior and posterior ends. The posterior spiracles and the chitin round the anal opening still darker coloured. Shape normal, the sides of the abdominal segments almost parallel, tapering towards the posterior end. The posterior end obliquely flattened, showing two stigma-bearing protuberances. The segmentation indicated by rows of transversely elongated spots. Below these spots here and there from 1 to 3 irregular, broken

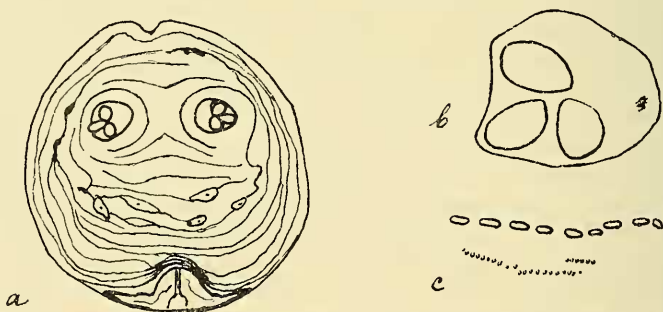


Fig. 31. *Phorbia genitalis* Schnabl; a posterior end ($\times 46$), b left posterior spiracle ($\times 230$), c fragment of a row of spots and a row of the very small spines ($\times 230$).

rows of extremely fine spines, even microscopically scarcely perceptible. On the sides every row of spots branched off into two rows, which join again somewhat farther on. The whole puparium very finely transversely wrinkled. On the ventral side here and there dark coloured spots, which on closer inspection appear to be many wrinkles close

together. The cephalopharyngeal skeleton reaching a short way into the first abdominal segment.

The number of lobes of the prothoracic spiracles indistinct. The posterior spiracles on conical protuberances, touching at their bases and situated in the dorsal half of the posterior end. The distance between the dark coloured spiracles circa one and a half times their own horizontal diameter. 3 broad converging lobes. Scar indistinct. No papillae on the posterior end. On the dorsal half faint indications of some swellings round the spiracles. Probably these are remnants of 3 pairs of dorsal papillae. Under the posterior spiracles 3 pairs of inconspicuous brown spots, which in their turn seem to contain a darker dot in their centre.

The puparium of this species is characterized by the absence of distinct papillae, the presence of the 3 pairs of spots below the posterior spiracles, and by the position and shape of the posterior spiracles.

A detailed description of the morphology and habit of *Phorbia genitalis* Schnabl is given by Mesnil and Pétré (1932).

They draw a sketch of the head of the larva, which is very conspicuous on account of its being partly covered by a reticular structure. The prothoracic spiracles of the larva are large and flat, lying close to the body. They are so to say double handshaped, either of them bearing 20 to 25 short lobes. The larva shows 11 "lignes de spicules intersegmentaires", apparently identical with what we call rows of spines. The first 5 of these rows run completely round the body of the larva, the following 6 are confined to the ventral side. The first belt seems to be very wide. It is mentioned by them, that these "spicules intersegmentaires" are hardly visible between the wrinkles of the puparium. The posterior end of the larva shows a number of singular, transparant tubercles, 6 of which are arranged in a transverse line. If a curved transverse line is meant here, it is very probable that the faint swellings, found by me on the puparium actually are remnants of these papillae. It is to be regretted that these authors do not give a sketch of the posterior end. Spots, as found by me on the puparia, are not mentioned by them. The position of the posterior spiracles is identical with what was seen by me on the puparium. Apparently the border round the anus, visible on the sketch given here, is considered by them as belonging to the anus itself, since they describe its width as being 3 times its length. Their description of the puparium is very short.

Phorbia genitalis Schnabl was pointed out by these investigators as being injurious to cereals in different parts of France. It also causes great damage to cereals in Russia and Hungary and occurs in Germany and in England too.

Usually the imagines are found during March and April in the cornfields. Probably the egg is laid on the upper leaf. The young larva, descending into the inner part of the plant, makes a spiral channel consisting of 4 or 5 turnings. By this the growth of the leaves is retarded and sap flows towards the place, where the larva lies. Owing to this the central part of the plant acquires a peculiar consistence round its terminal bud. Here the larva develops. The attacked plant changes its colour: the youngest leaf becomes yellow, the other leaves remain green. In France these deviations appear in the second part of May, and in the first days of June. The deviations, caused by *Oscinella frit* L., which are very similar, do not appear before the middle of June. In June the larva pupates inside the channel. The imago does not appear until the following spring. In the mediterranean regions a second generation seems to appear in late autumn and may cause great damage to the young cereals.

***Heterostylus pratensis* Mg.**
Chortophila pratensis Mg.

Fig. 32.

Place where the puparia were found not known.

The two specimens present small: length 4 mm., largest diameter circa 1 mm. Colour yellowish brown. Shape normal, tapering towards the last segment, which has parallel sides. Posterior end obliquely flattened, showing two short stigma-bearing protuberances and a number of small papillae. Segmentation distinct. The spots at the junction of the segments inconspicuous. Ventrally on the anterior border of the abdominal segments belts of small spines. The belts widest in the middle and narrowing towards the sides. Each belt consisting in the middle of 5 to 7 irregular rows, only the first belt is narrower and less conspicuous. Most spines with their tops towards the posterior end. Only a few spines, situated on the posterior border of the segments, turned forwards. On the dorsal and lateral sides no spines or only a few. On either side 2 rows of slight hollowings-out. The whole puparium finely transversely wrinkled, more irregularly on the first 2 thoracic segments. The cephalopharyngeal skeleton reaching well into the first abdominal segment.

On the larval prothoracic spiracles 11 or 13 lobes. The posterior spiracles on short, somewhat diverging protuberances, touching the medio-horizontal plane. The distance between them somewhat less than once their horizontal diameter. Either spiracle with 3 slits, converging to the scar, which is situated in the middle of the inner edge of the stigmal plate. 8 pairs of small papillae on the posterior end: 3 pairs on the dorsal half, and 5 pairs on the ventral

half. The pair nearest to the median line small and seemingly bifid. The slit-like anal opening surrounded by a brown, transverse-elongated border.

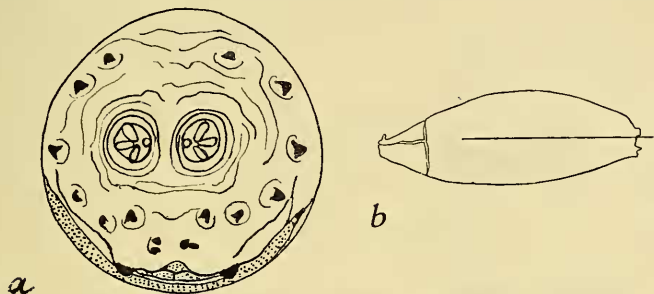


Fig. 32. *Heterostylus pratensis* Mg.; a posterior end ($\times 46$), b lateral view with medio-horizontal line, schematic ($\times 8,5$).

The position and shape of the posterior spiracles, and the 8 pairs of papillae are the most characteristic features of the puparia of this species. They show a very close resemblance to specimens of *Paregle aestiva* Mg. (see fig. 34a). No real distinguishing characteristic could be found.

***Paregle aestiva* Mg.**

Chortophila (Paregle) aestiva Mg.

Fig. 33.

Puparia found in alluvial deposit of river Rhine near Herwen.

Small: length from 3 to 4.5 mm., largest diameter 1,5 mm. Colour varying from yellowish brown to reddish brown. Shape normal, narrowing suddenly towards the anterior end, and tapering towards the last segment, which has parallel sides. Posterior end obliquely flattened, showing two stigma-bearing protuberances and a number of papillae. Segmentation distinct. On the anterior border of the abdominal segments belts of spines, arranged in irregular rows. The spines rather inconspicuous, few in number, sometimes even totally lacking on the dorsal and lateral sides. On each lateral side 2 rows of slight hollowings-out, in most of which some dark spots are perceptible. The first two thoracic segments irregularly wrinkled, the rest of the puparium finely transversely wrinkled. The cephalopharyngeal skeleton reaching well into the first abdominal segment.

10 or 11 lobes on the larval prothoracic spiracles. The posterior spiracles on short, somewhat diverging protuberances, touching the medio-horizontal plane. The

distance between the spiracles circa once their horizontal diameter. The 3 slits of either spiracle lying at acute angles, converging to the scar, which is situated in the middle of

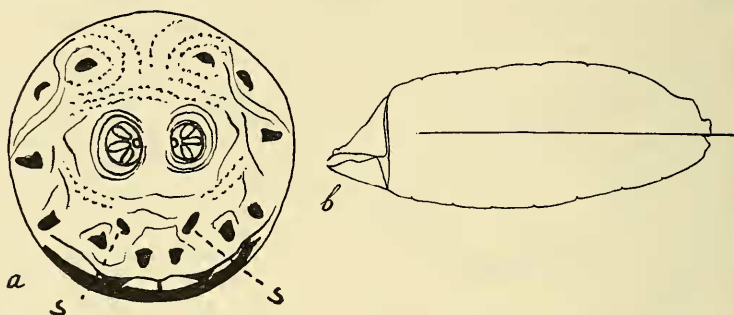


Fig. 33. *Paregle aestiva* Mg.; a posterior end ($\times 46$), b lateral view of the puparium with medio-horizontal line, schematic ($\times 13$).

the inner edge of the stigmal plate. The posterior end showing 7 pairs of papillae and 1 pair of brown, raised spots (s), which vary in shape, and may even be lacking. On some specimens rows of minute spines on the posterior end.

The 7 pairs of papillae and the pair of brown, raised spots, the position of the spiracles and of the slits are the most characteristic features of the puparia of this species.

***Paregle cinerella* Fall.**
Chortophila (Paregle) cinerella Fall.

Fig. 34.

Puparium found in alluvial deposit of river Rhine near Herwen.

The only specimen, present in the collection, small: length 3.75 mm., largest diameter 1.5 mm. Colour shiny dark brown. Shape normal, the sides of the first abdominal segments parallel, tapering towards the caudal end. Posterior end obliquely flattened, showing two stigma-bearing swellings and a number of more or less distinct papillae. Segmentation distinct. At the anterior margin of the first and last abdominal segments only ventrally some rows of very fine spines. The other abdominal segments each completely surrounded by a belt of small spines at their anterior end, with in front a row of distinct brown spots. The belts equally wide on the dorsal and ventral sides. The first four belts consisting of 6 to 8 rows of spines, the others being somewhat narrower. All spines with their tops towards the posterior end. Most spines situated one by one in rather straight rows, only on the dorsal side of the first segments and in the last rows of the ventral belts the spines arranged close to each other

or joined together in small groups. The whole puparium heavily transversely wrinkled, somewhat less in the last 4 belts of spines. On either side 3 longitudinal rows of slight hollowings-out, each segment showing on either side 3 pits next to one another. Microscopically some dark spots discernible in these pits.



Fig. 52. *Paregle cinerella* Fall.; posterior end₂($\times 46$).

The larval prothoracic spiracles brown, the number of lobes indistinct. The posterior spiracles on slight swellings, situated on the dorsal half, touching the horizontal diameter of the posterior end. The distance between the spiracles almost as long as their own horizontal diameter. Either spiracle with 3 wide lobes. The upper rim of the middle lobes almost horizontal. The two other lobes lying at acute angles to this lobe. The round scar situated in the middle of the inner edge. Round the spiracles 5 pairs of papillae, the 3 pairs on the dorsal half slightly raised and less distinct than the 2 pairs of papillae on the ventral half. At the bottom a sixth pair of papillae and a brown spot in the median line, this side of the slit-like anal opening. Under the spiracles an area showing irregular spots, where the chitin is somewhat darkened.

The 6 pairs of papillae on the posterior end, the distance between the posterior spiracles and the position of the slits are the most distinguishing characteristics of the puparium of this species.

Séguy mentions that, according to Bezzi, the larva lives in human excrements.

Paregle radicum L.

Chortophila (*Paregle*) *radicum* L.

Fig. 35.

Puparia found in alluvial deposit of river Rhine near Herwen.

Small: length from 4,5 to 5,5 mm., largest diameter from

1,5 to 2 mm. Colour varying from grey-brown to brown. The papillae on the posterior end and the spiracles coloured somewhat darker than the rest of the puparium. Shape normal, tapering towards the caudal end, the ventral side flattened, the dorsal side convex. Posterior end flattened somewhat obliquely, bearing long, slender, pointed papillae and two shorter stigma-bearing protuberances. The first and the second thoracic segments, sometimes even the third segment without spines. The abdominal segments completely beset with long, sharp, pointed spines. Only the borders of the segments may be spineless. Most spines with their tops towards the posterior end. Only on the third to seventh abdominal segments the last rows of spines with their tops towards the anterior end. On some specimens the tops of the spines so very thin that magnified a few times, one receives the impression as if the surface were beset with hairs instead of spines.

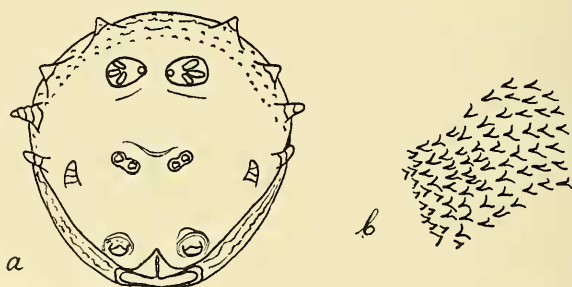


Fig. 35. *Paregle radicum* L.; a posterior end ($\times 30$), b part of a belt of spines ($\times 154$).

The larval prothoracic spiracles indistinct, dark coloured, 8 lobes noticed. (Bouché (1834) counts from 7 to 10 lobes on the larva, Hewitt (1910) counts 13 lobes). The posterior spiracles on short protrusions, situated high up in the dorsal half of the posterior end. The stigmal plates transverse-oval, close together: the distance between them circa half as long as their horizontal diameter. Either spiracle with three elongated slits, converging to the scar, which is situated at the inner edge of the stigmal plate. Round the spiracles 5 pairs of long, pointed, slightly curved papillae. The chitin of these papillae often wrinkled. Under the spiracles near the median line a sixth pair of smaller, less raised, bifid papillae, or 2 pairs of slightly raised, yellowish-brown spots, close together. At the bottom, at this side of the anal opening another pair of distinct papillae. Short spines may be present.

The foregoing description agrees for the greater part with the description given by Bouché (1834). A difference is that he mentions the slits as being parallel. In fact the slits are

converging, though at acute angles. The number and arrangement of the papillae on the posterior end agrees quite with the sketch and description of the larva given by Hewitt.

The female lays about 100 eggs, which are deposited in groups of 20 to 25 in manure or at the bases of plants. Hatching takes place between the second and third day. The development of the larvae takes from 8 to 12 days. They live in decomposing animal or vegetable matter or in the roots of different kinds of cabbage and in radish. The larva pupates in the earth or under dead leaves; the pupal stage lasts 10 days. The puparium hibernates (Bouché, Ségué).

The most characteristic features of the puparia of this species are the large number of spines on the abdominal segments, the 7 pairs of long papillae, one pair of which is bifid, and the position and shape of the posterior spiracles.

Trägårdh (1913) treats the question whether *Egle* (*Anthomyia*) *spretæ* Mg., is to be identified with *Paregle* (*Anthomyia*) *radicum* L. or not. The larvae of *Egle spretæ* Mg. are found on *Epichloë typhina* (Pers.) Tul., which develops on various Gramineae, as *Phleum pratense* L., and *Dactylis glomerata* L. After having described the larva of *Egle spretæ* Mg., and after comparing it with the description of *Paregle radicum* L. by Hewitt, he arrives at the conclusion that they are not identical, and that the larvae, in fact, are easily distinguishable. From his description of the larva of *Egle spretæ* Mg. the following may be quoted here: "In the third instar the anterior spiracles have 24 "buttons". The posterior end is characterized by the arrangement and size of the small, conical appendages, which surround the somewhat excavated circumstigmatal area. They are placed, one pair dorsally, two laterally and three ventrally. The distance between the dorsal ones is as long as that between the lateral ventral pair. The median ventral pair is placed so closely together that it appears to be one bifurcated tubercle".

To judge from this description it appears that there are differences with the puparium of *Paregle radicum* L. in the following features: the number of lobes on the prothoracic spiracles, the number of papillae on the posterior end, and the position and shape of the median ventral pair.

BIBLIOGRAPHY.

- Banks, N., The Structure of Certain Dipterous Larvae with Particular Reference to those in Human Foods. U. S. Dep. of Agric. Bur. of Entom. Techn. series No. 22. 1912.
- Bouché, P. F. Naturgeschichte der Insecten (besonders in Hinsicht ihrer ersten Zustände als Larven und Puppen). Berlin 1834.
- Brauer, Fr., Monographie der Oestriden. Zool.-bot. Ges. Wien. 1863.
- , Die Zweiflügler des kaiserl. Museums zu Wien, III. Denkschr. des Kais. Akad. der Wiss. Wien; Math. Naturwiss. Klasse. Bd. XLVII. 1883.
- Bremer, H. und Kaufmann, O., Die Rübenfliege. Monographien zum Pflanzenschutz No. 7. 1931.
- Cameron, A. E., A Contribution to the Knowledge of the Belladonna Leaf-Miner, *Pegomyia hyoscyami* Panz., its Life History and Biology. Ann. Appl. Biol. I. 1914—1915.
- , Some Experiments on the Breeding of the Mangold Fly (*Pegomyia hyoscyami* Panz.) and the Dock Fly (*Pegomyia bicolor* Wied.). Bull. Ent. Res. VII. 1916—1917.
- Frost, S. W., A Study of the Leaf-Mining Diptera of North America. Corn. Univ. Agric. Exp. Stat. Mem. 78. 1923.
- Greene, Ch. T., An Illustrated Synopsis of the Puparia of 100 Muscoid Flies (Diptera). No. 2405 Proc. U. S. Nat. Mus. Vol. 60. art. 10.
- , Puparia and Larvae of Sarcophagidae. Proc. of the U. S. Nat. Mus. Vol. 66. 1925.
- , Description of Larvae and Pupae of Two-Winged Flies, belonging to the Family Leptidae, Proc. of the U. S. Nat. Mus. Vol. 70. 1926.
- , Characters of the Larvae and Puparia of Certain Fruit Flies. Journ. Agric. Res. vol. 38. 1929.
- Herrick, G. W. and Colman, W., The Cabbage Maggot. Corn. Univ. Agric. Exp. Stat. New-York. Bull. 413. 1922.
- Hewitt, C. G., The House Fly. Manchester Univ. Pres. 1910.
- , *Fannia* (*Homalomyia*) *canicularis* L. und *Fannia scalaris* Fabr. Par. V. 1912.
- Howard, L. O., A Contribution to the Study of the Insect Fauna of Human Excrement. Proc. of the Wash. Ac. of Sc. Vol. II. 1900.
- Imms, A. D., A General Textbook of Entomology.

- Karl, O. Zweiflügler oder Diptera III: Muscidae. Die Tierwelt Deutschlands und der angrenzenden Meeressteile. 13 Teil. 1928.
- Keilin, D., Les formes adaptatives des larves des Anthomyides; les Anthomyides à larves carnivores. Bull. de la Soc. Ent. de France. 1914.
- , Recherches sur les Anthomyides à larves carnivores. Parasitology. Vol. IX. No. 3. 1917.
- , On the Life-history of *Anthomyia procellaris* Rond. and *A. pluvialis* L. inhabiting the Nests of Birds. Par. XVI. 1924.
- , and Tate, P., On Certain Semi-carnivorous Anthomyid Larvae. Par. XXII. 1930.
- Kemner, N. A. Betflugan. Meddelande N:r 288 från Centralanstalten för försöksv. på jordbruksområdet. Ent. avdelningen 47. 1925.
- Malloch, J. R., A Preliminary Classification of Diptera, exclusive of Pupipara, based upon Larval and Pupal Characters, with Keys to Imagines in Certain Families. Bull. Illin. State Labor. Nat. Hist. Vol. XII. 1918.
- Marno, E., Die Typen der Dipteren-Larven als Stützen des neuen Dipteren-Systems. Verhandl. der zoöl-bot. Ges. Wien. Bd. XIX. 1869.
- Mesnil, L. et Pétré, F., Un Anthomyide nuisible aux Céréales en France. Bull. de la Soc. ent. de France. Séance du 12 oct. 1932.
- Miall, Prof. L. C. and Taylor, T. H., The Structure and Life-History of the Holly-Fly. Trans. Ent. Soc. London. 1907.
- De Meijere, J. C. H., Ueber zusammengesetzte Stigmen bei Dipterenlarven. Tijdschr. v. Entom. Deel 38. 1895.
- , Ueber die Larve von Lonchoptera. Zoöl. Jahrb. Abt. Syst. Bd. 14. Heft 2. 1900.
- , Ueber die Prothorakalstigmen der Dipterenpuppen. Zoöl. Jahrbücher. Abt. An. und Ont. Bd. 15. Heft 4. 1902.
- , Ueber in Farnen parasitierende Hymenopteren- und Dipteren-Larven. Tijdschr. voor Entom. Deel 54. 1911.
- , Zur Kenntnis der Metamorphose von Platypeza und der verwandtschaftlichen Beziehungen der Platypezinen. Tijdsch. v. Entom. Deel LIV, 1911.
- , Beiträge zur Kenntnis der Dipteren-Larven und -Puppen. Zoöl. Jahrb. Bd. 40. 1916.
- , Verslagen van de 80ste en 81ste zomervergadering der Ned. Ent. Ver. Juni 1925 en 1926. Tijdschr. v. Ent. LXVIII en LXIX.
- , Die Larven der Agromyzinen. Tijdschr. v. Ent.

- Deel LXVIII 1925, LXIX 1926, LXXI 1928, LXXVII 1934.
- Nielsen, J. C., *Mydaea anomala* Jaenn. A parasite of South-Amer. birds. Vid. Meddel. pa der Naturh. For. i. Kjøbenhavn. Bd. 63. 1912.
- , Undersøgelser over entoparasitiske Muscidelarver hos Arthropoder. Vid. Meddel. pa der Naturh. For. i. Kjøbenhavn. Bd. 63—67. 1912—1916.
- , Iagttagelser over entoparasitiske Muscidelarver hos Arthropoder. Entom. Meddel. Serie II. Bd. 4. 1913.
- Pantel, J., Sur l'unification du nombre des segments dans les larves des Muscides. C. R. de L'ac. des Sc. Tome 148. 1909.
- Patton, W. and Evans, A. M., Insects, Ticks, Mites and Vennomous Animals of Medical and Veterinary Importance. Great Britian 1929.
- Séguy, E., Diptères Anthomyides. Faune de France. 1923.
- , Les insectes parasites de l'homme et des animaux domestiques. Encyc. prat. du Naturaliste. XVIII. Paris. 1924.
- Smith, K. M., A Study of the Life-History of the Onion Fly (*Hylemyia antiqua* Mg.). Ann. Appl. Biol. IX. 1922.
- , A Study of *Hylemyia* (*Chortophila*) *brassicae* Bouché, the Cabbage-Root Fly and its Parasites. Ann. Appl. Biol. XIV 1927.
- Sorauer, P., Handbuch der Pflanzenkrankheiten. Bd. V. 1932.
- Thompson, W. R., A Contribution to the Study of Morphogenesis in the Muscoid Diptera. Trans. Ent. Soc. London 1929.
- Trägårdh, Ivar, En svampätande Anthomyid-larv Egle (*Anthomyia*) *spretata* Mg. Arkiv för Zool., K. Svenska vetenskapsak. i Stockholm. Bd. 8. No. 5. 1913.
- Thomas, I., On the Bionomics and Structure of some Dipterous Larvae, infesting Cereals and Grasses. Ann. Appl. Biol. XX. 1933.
- Unwin, E., The Vinegar-Fly (*Drosophila funebris*). Trans. Ent. Soc. London 1907.
- Vimmer, Ant., Príspevky k poznáni kukel hmyzu dvoj-kridlého Diptera cyclorrhapha. Acta Societatis Entomologicae Bohemiae 1911. Rocník VIII., cis. 2.—
- , Beiträge zur Kenntnis der cyclorrhaphen Dipterenpuppen. Acta Soc. Ent. Boh. VIII No. 1 und 2 1911.
- , O kukle *Lonchaea viridana* Mg. a nekolik poznámek o kuklách *Cyclorrhaph* vubec. Act. Soc. Ent. Boh. Boh. X 4 1913.
- , O larvach Dipter z balknskisch jeskyn. Zolastni

otisk z casopisu moravskeho musea zemskeho V 1919.

———, Beiträge zur Bestimmung der Tachinenlarven. Casopis Cs. Spol. Ent. XXXI 1934.

———, Ueber die Metamorphose von *Aricia laeta* Fall., nebst einigen Bemerkungen über die Dipteren-Larven und Puppen. Soc. Ent. Jahrg. 26.

De Vos-de Wilde, B., Contribution à l'étude des larves de Diptères Cyclorrhaphes, plus spécialement des larves d'Anthomyides. Proefschrift 1935.

CONTENTS.

	page
Introduction	94
Subfamily Muscinae	102
<i>Musca domestica</i> L.	102
<i>Myiospila mediatubunda</i> Fabr.	103
<i>Mesembrina meridiana</i> L.	105
<i>Muscina stabulans</i> Fall.	106
<i>Morellia aenescens</i> Rob. Desv.	110
" <i>hortorum</i> Fall.	111
<i>Haematobia stimulans</i> Mg.	113
<i>Lyperosia irritans</i> L.	114
Subfamily Anthomyinae	115
<i>Pegomyia bicolor</i> Wied.	115
" <i>hyoscyami</i> <i>hyoscyami</i> Panz.	117, 121
" " Panz. var. <i>betae</i> Curtis	117, 122
" " " var. <i>chenopodii</i>	Rond. 117, 123
" " " var. <i>silenes</i>	Hering 117, 124
" <i>nigritarsis</i> Zett.	125
<i>Hylemyia lasciva</i> Zett.	127
" <i>nigrimana</i> Mg.	128
" <i>pilipyga</i> Vill.	129
<i>Chortophila</i> (<i>Egeria</i>) <i>brassicae</i> Bouché	131
" " <i>cinerea</i> Fall.	134
" " <i>discreta</i> Mg.	135
" " <i>latipennis</i> Zett.	136
" " <i>lineata</i> Stein	138
" " <i>pullula</i> Zett.	139
" " <i>seneciella</i> Meade	141
" " <i>signata</i> Brischke, de Meijere	143
" (<i>Crinura</i>) <i>antiqua</i> Mg.	145
" " <i>florilega</i> Zett.	147
" (<i>Thrixina</i>) <i>fugax</i> Mg.	148
" " <i>octoguttata</i> Zett.	150
" (<i>Nudaria</i>) <i>dissecta</i> Mg.	151
" " <i>intersecta</i> Mg.	153
<i>Pycnoglossa cinerosa</i> Zett.	154
<i>Phorbia genitalis</i> Schnabl	156
<i>Heterostylus pratensis</i> Mg.	158
<i>Paregle aestiva</i> Mg.	159
" <i>cinerella</i> Fall.	160
" <i>radicum</i> L.	161
Bibliography	164